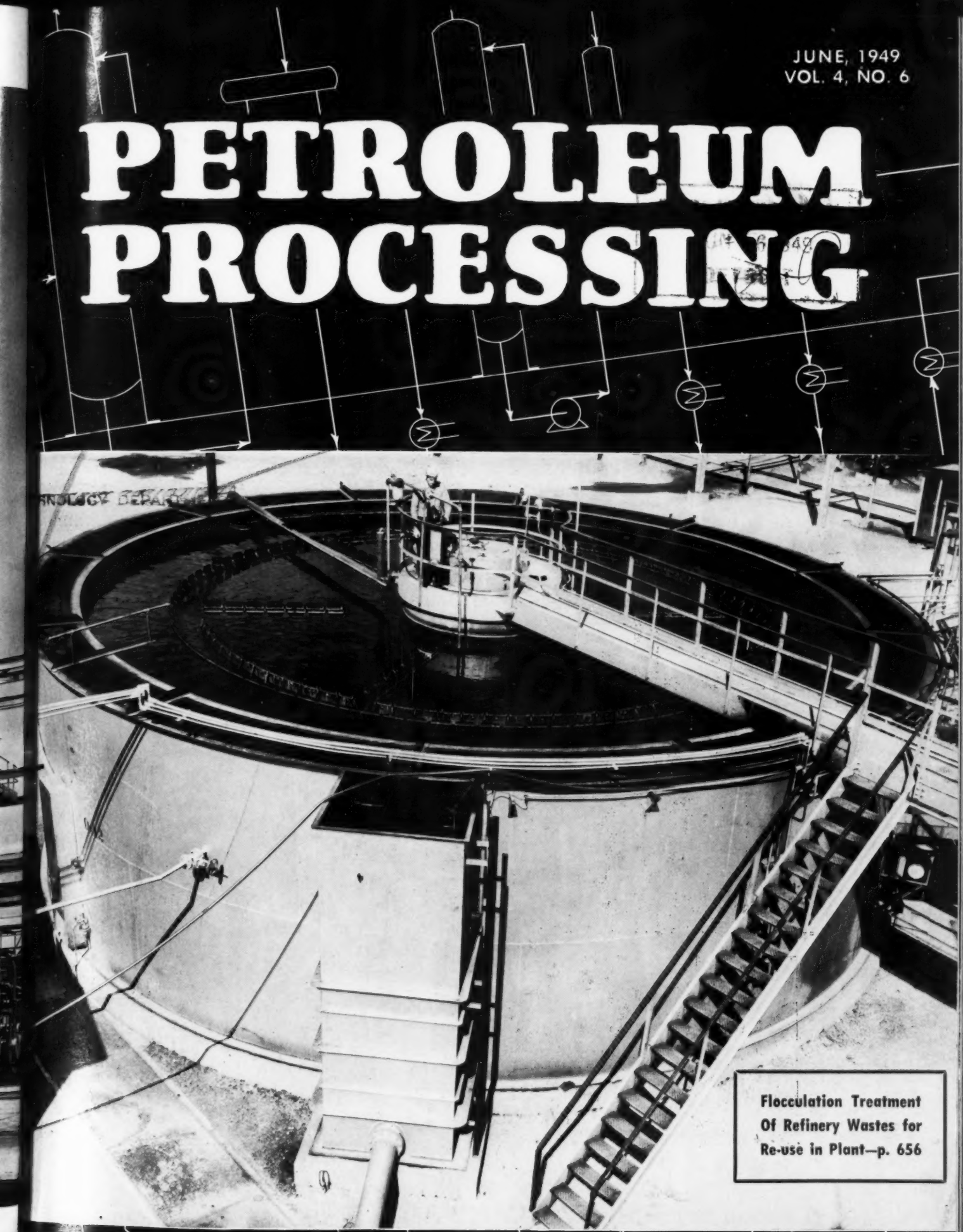
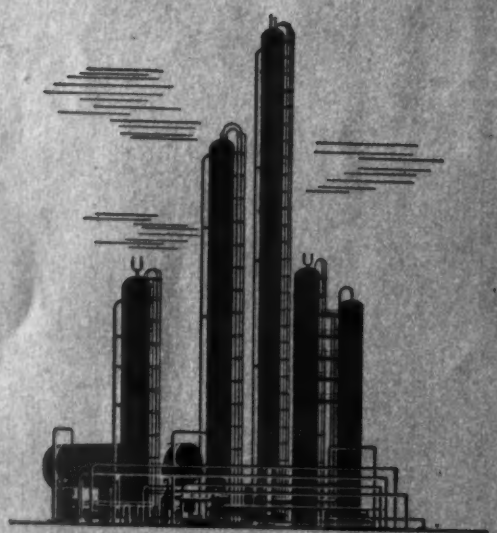
JUNE, 1949
VOL. 4, NO. 6

PETROLEUM PROCESSING



Flocculation Treatment Of Refinery Wastes for Re-use in Plant—p. 656



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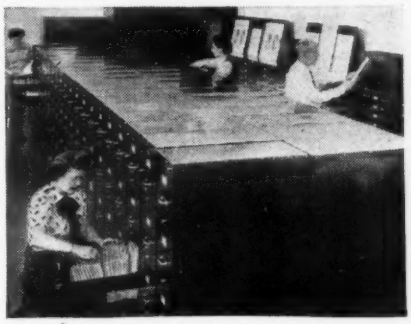
Frequently, before experimental engines are put into production, the Laboratories subject them to exhaustive tests. If any incompatibility with petroleum products appears, modifications are made until successful results are achieved. Information so obtained is passed along to the engine manufacturers. All the wide variety of Ethyl's varied research facilities, including a cold room (right), are available for such work.

•

As a result of experience gained over more than 26 years, Ethyl Laboratories are able to evaluate petroleum products in respect to the results they may be expected to give in a wide variety of gasoline engines. The performance of many types of gasolines and lubricating oils is continuously observed. If any incompatibility of these products with engines in production is noticed, the results are passed along to the oil companies.



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Many members of the Ethyl Laboratories are authorities on engine-fuel relationships and are always available to engineers of automotive companies for consultation in connection with research programs conducted in their own laboratories. Likewise, Ethyl technologists are glad to discuss with the technical people of oil companies the performance of their products as it is revealed in research programs and in field service.

•

Occasionally operating problems develop in the field because of abnormal conditions which could not be anticipated during the design of the engines. When this happens, the Ethyl Laboratories, having the benefit of specific information supplied by the field organization, work closely with the oil and automotive companies concerned.

•

A further extension of Ethyl's work in the field is the maintenance of contact with the operators of truck, bus and passenger car fleets. Based on field observations and on special research work conducted in the Ethyl Laboratories, recommendations are made to engine users to assist them in obtaining the best engine performance and durability on the fuels and crankcase lubricants used.

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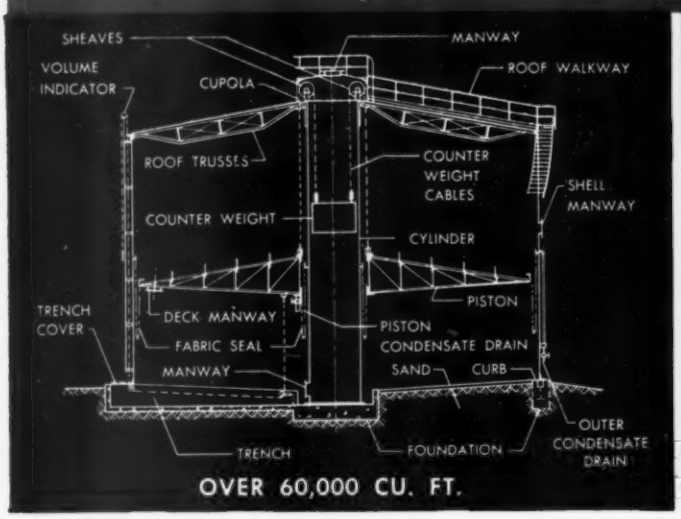

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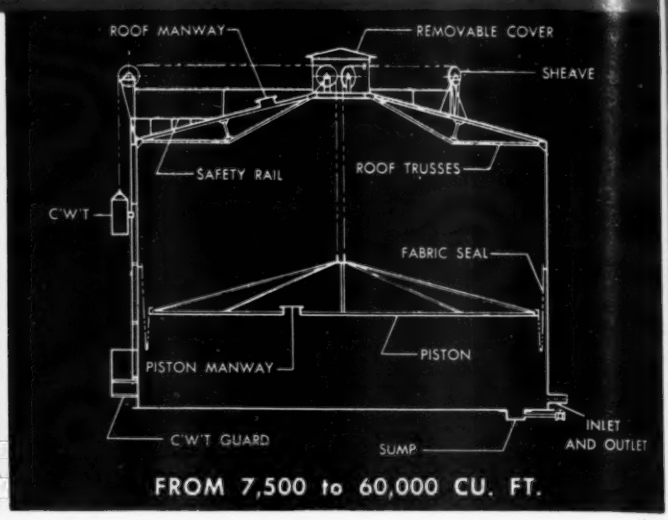

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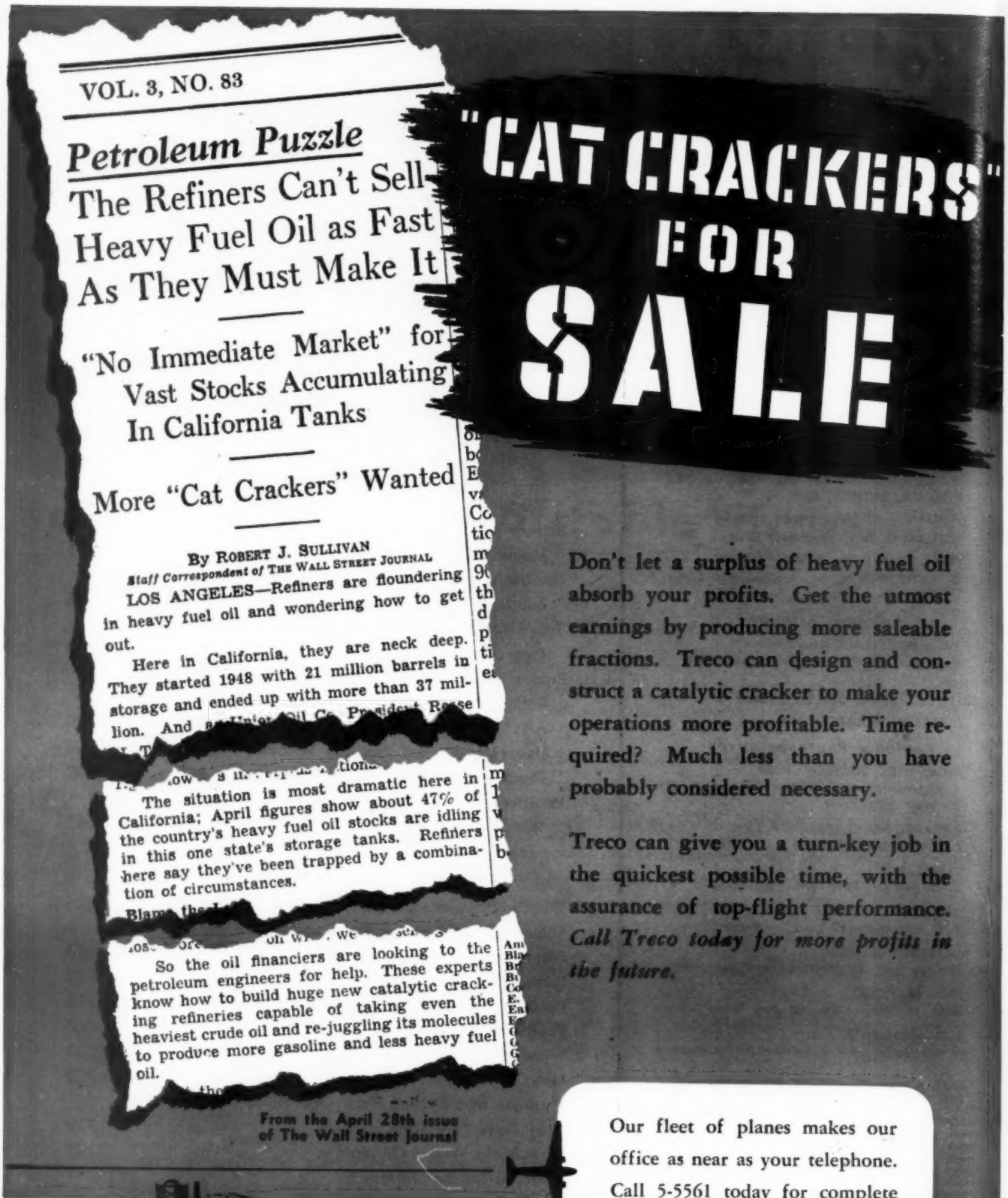
VOL. 3, NO. 83
Petroleum Puzzle
The Refiners Can't Sell Heavy Fuel Oil as Fast As They Must Make It
"No Immediate Market" for Vast Stocks Accumulating In California Tanks
More "Cat Crackers" Wanted
By ROBERT J. SULLIVAN
Staff Correspondent of THE WALL STREET JOURNAL
LOS ANGELES—Refiners are floundering in heavy fuel oil and wondering how to get out.
Here in California, they are neck deep. They started 1948 with 21 million barrels in storage and ended up with more than 37 million.
The situation is most dramatic here in California; April figures show about 47% of the country's heavy fuel oil stocks are idling in this one state's storage tanks. Refiners here say they've been trapped by a combination of circumstances.
So the oil financiers are looking to the petroleum engineers for help. These experts know how to build huge new catalytic cracking refineries capable of taking even the heaviest crude oil and re-juggling its molecules to produce more gasoline and less heavy fuel oil.
From the April 28th issue of The Wall Street Journal
"CAT CRACKERS" FOR SALE
Don't let a surplus of heavy fuel oil absorb your profits. Get the utmost earnings by producing more saleable fractions. Treco can design and construct a catalytic cracker to make your operations more profitable. Time required? Much less than you have probably considered necessary.
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So, whether you're making a new installation or need replacements, be sure to specify Powell Valves. And remember Powell Engineering Service is always at your disposal in selecting the correct valves to meet your individual requirements.

Fig. 3003—Class 300-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke and tapered solid wedge.

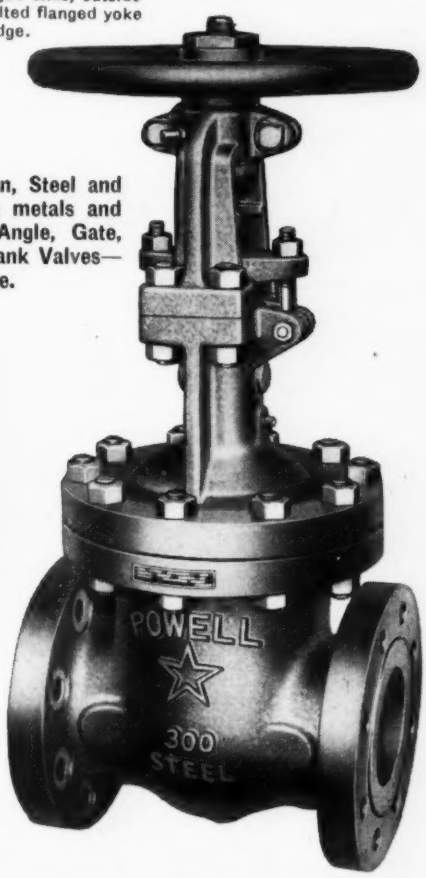

Fig. 375 — 200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

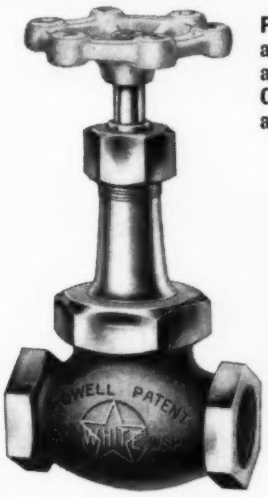

Fig. 1708 — 200-pound Bronze Globe Valve with screwed ends, union bonnet, renewable, specially heat treated stainless steel seat and regrindable, renewable wear-resisting "Powellium" nickel-bronze disc.

Powell Valves are made in Bronze, Iron, Steel and a wide selection of Corrosion-Resistant metals and alloys. Valves of every type—Globe, Angle, Gate, Check, Non-return and Flush Bottom Tank Valves—are included in the Complete Powell Line.

Fig. 559—125-pound Iron Body Bronze Mounted Swing Check Valve. Flanged ends, bolted flanged cap and regrindable, renewable bronze seat and disc. Disc, when wide open, permits full, unobstructed flow through valve body

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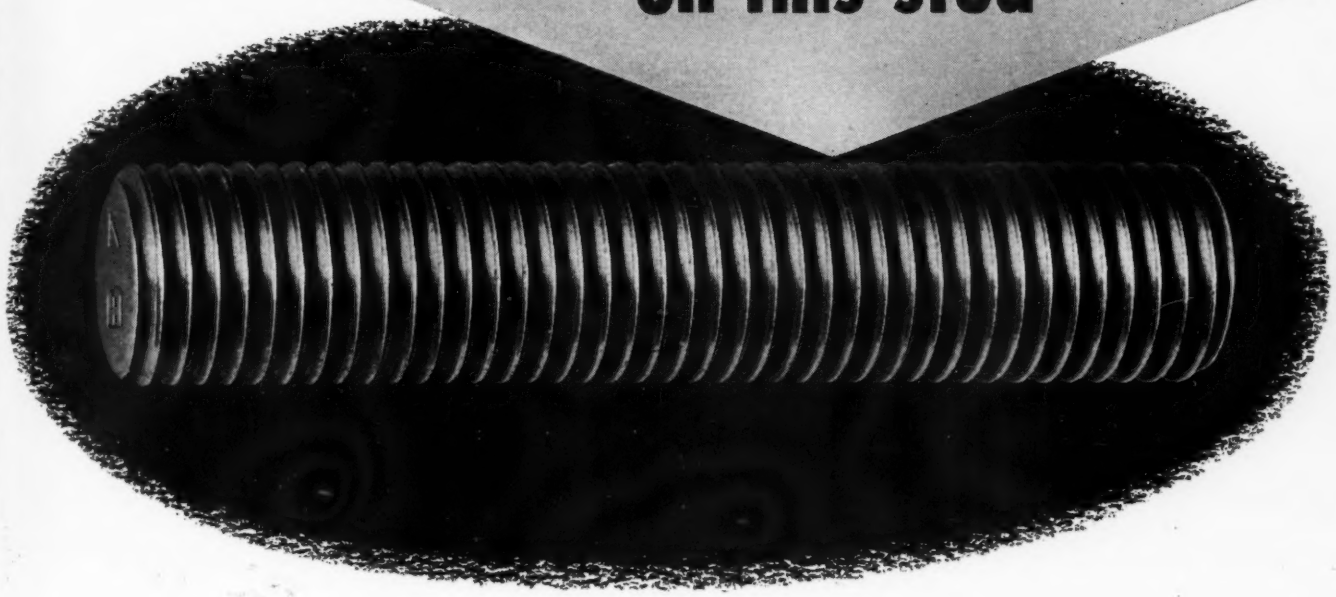

All too frequently stress-concentrations have been the cause of stud failure in the high-temperature bolting jobs encountered in refineries. But with the Bethlehem continuous-thread stud shown here, failure is practically unheard of, regardless of high temperatures or high pressures.

The Bethlehem continuous-thread stud resists stress-concentrations because it has no point of thread run-out. Those stresses which do occur are effectively distributed over the entire length of the stud, thus enabling it to provide economical performance for long periods of time.

The Bethlehem continuous-thread stud is made from carbon or alloy steels, and comes either plain or heat-treated. It is furnished in a complete range of diameters and in any length, with most sizes carried in stock.

Bethlehem also manufactures the continuous-thread tap-end stud for installations requiring but one nut. This stud has its chamfered tap-end threaded to Class 5 fit, and its rounded nut-end threaded to either Class 2, 3 or 7 fit, yet the blending of threads is accomplished so skillfully that the point of change is undetectable.

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MARLEY ANNOUNCES NEW DriCooler

Cooling Tower Manufacturer Supplements Line With Finned-Tube Dry Surface Cooling Equipment

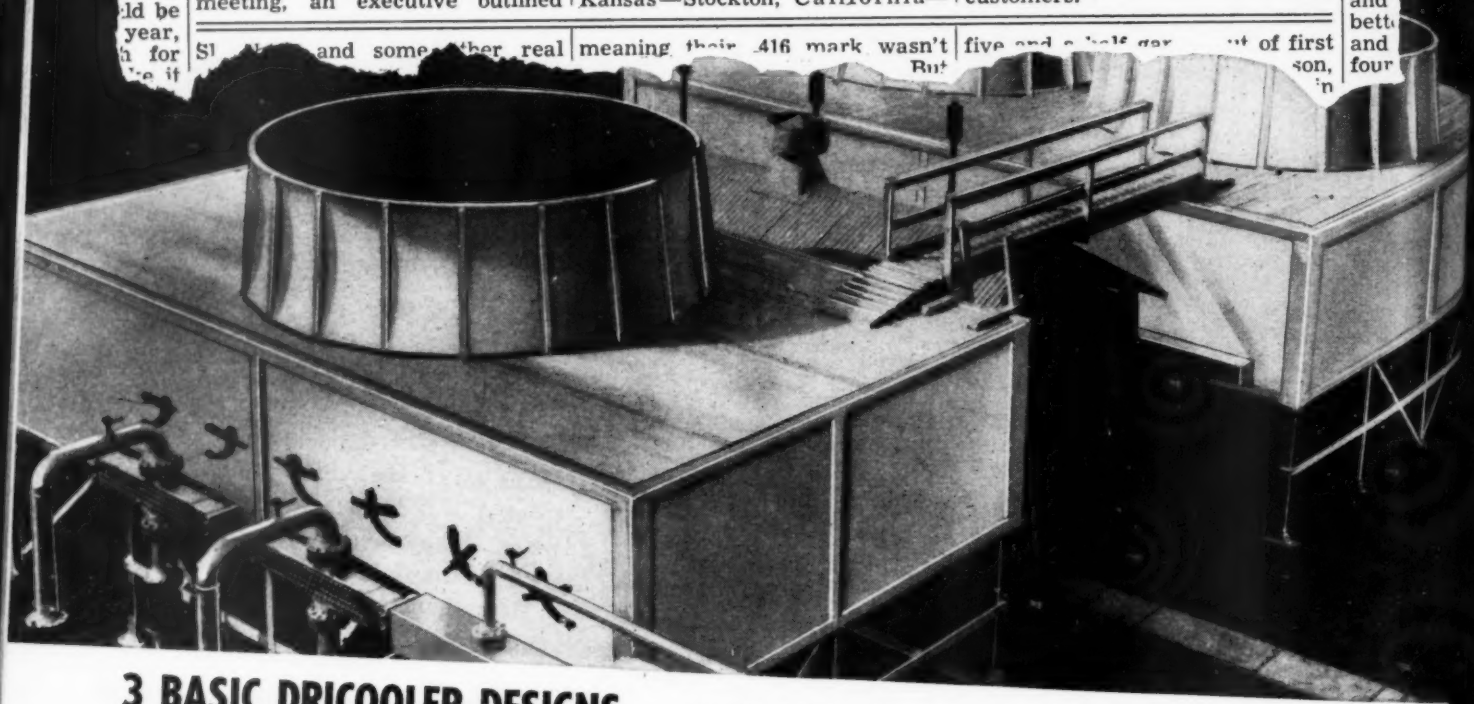
Kansas City, Kans., April 3.—The Marley Company, Inc., manufacturers of water cooling products, have announced that they are introducing a new product, the DriCooler.

Company officials said that The Marley Company has been manufacturing similar finned-tube dry surface cooling equipment for another company for some time. This equipment cools fluids by circulating them through finned tubes while air is forced or induced across their surface with a large fan.

At a recent board of directors' meeting, an executive outlined the company's position. "Our fans, drive shafts, Geareducers, and fan cylinders, which have proved so successful on our water cooling towers, are used on the DriCooler. Framing, either wood or metal, is also similar to that used in cooling tower design. We have developed something new, a sheet asbestos covered redwood frame that requires little maintenance, even in very corrosive atmospheres.

"For the present we will alter our three basic DriCooler designs to meet the customers' specifications. With our Kansas City, Kansas—Stockton, California—Louisville, Kentucky, plants now in operation, we have the flexibility to turn out special as well as standard designs. All parts of the DriCooler are designed and manufactured by us except the heat transfer surface which is made to Marley's specification.

"Although water cooling towers and DriCoolers have individual applications, the fields often overlap and a thorough evaluation must be made of both types of equipment to determine which is more economical. Since we make both kinds of equipment, we are in a position to better serve our customers."



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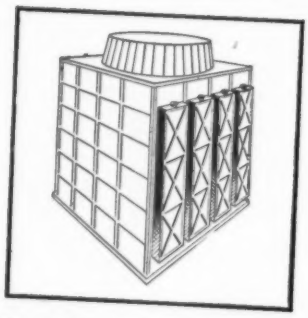
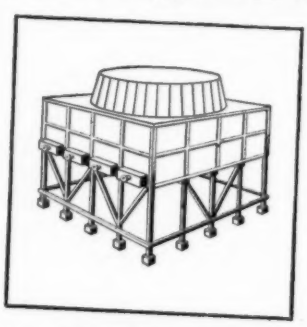
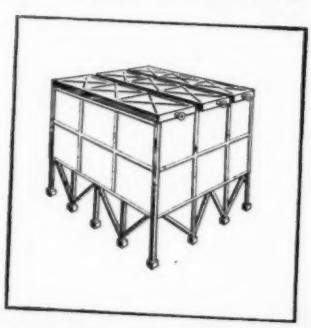
No matter what your cooling needs may be, MARLEY DriCoolers or Cooling Towers will do the job. Ask for a Marley Trained Application Engineer to help you analyze your requirements and recommend the equipment best suited to your purpose. No cost or obligation.



1. Induced Draft vertical or horizontal heat transfer surface on two sides.



2. Induced Draft horizontal heat transfer surface under the fan.

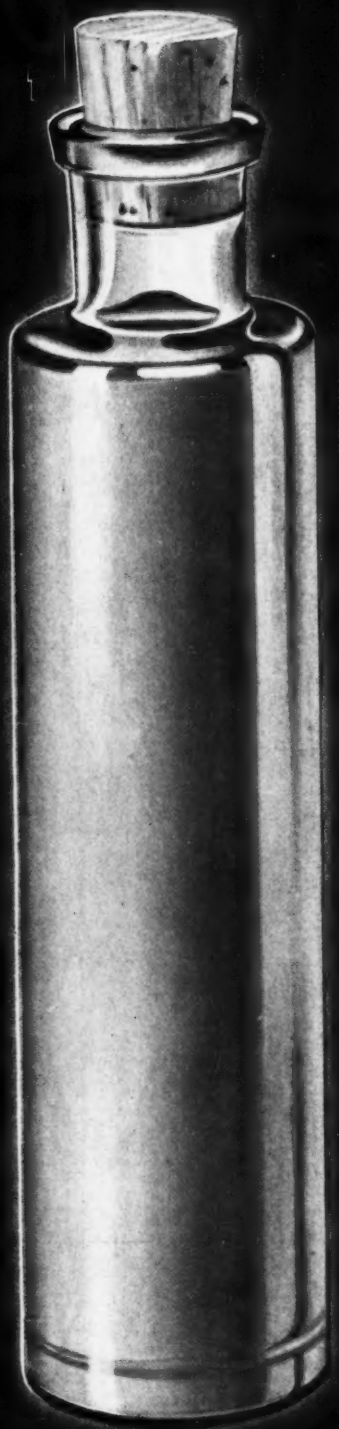


3. Forced Draft horizontal heat transfer surface over the fan.

*DriCooler is the exclusive trademark of The Marley Co., Inc., and is used to designate its finned tube dry cooling equipment.

MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS



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What's Happening!

Important Current News Summarized for Refiners

REFINERY OPERATIONS

Crude runs to still during May showed no particularly drastic change over previous month's operations, staying around 5,250,000 b/d. A year ago in May, crude runs were as high as 5,640,000 b/d.

The refiner's "margin" has shrunk 35c per bbl., or approximately 30%, in the six months from October, 1948, to April, 1949, according to figure compiled by the Independent Petroleum Assn. of America. Based on published prices, IPAA computes weighted average prices for motor gasoline, kerosene, light fuel, and heavy fuel in nine principal refinery markets in the U. S., and for crude oil in eight of the principal producing areas of the country. Although not representing actual total realization from a barrel of crude, the weighted prices of the four principal products reflect changes in price levels for the major part of refinery output and thereby indicate approximately changes in this realization.

High point in refiner's "margin" in the postwar period was reached in October, 1948, when IPAA's product average stood at $3.74 per bbl. with a crude price average of $2.59, or a price spread of products over crude of $1.15 per bbl. By April, 1949, the spread had dwindled to 80c per bbl., the two averages standing at $3.36 and $2.56 per bbl., respectively.

• • •

LABOR

Earnings of plant workers in petroleum refineries are third highest in American industry, according to a special study recently completed by the Bureau of Labor Statistics. Straight-time average hourly wages in refineries were $1.78 an hour in September, 1948, the study shows, with about three-fourths of the workers receiving between $1.50 and $2.10 an hour. Study was based on a survey of 122 refineries employing over 100,000 plant workers.

Survey also shows that, on the average, earnings were highest in the Great Lakes region and lowest in the Middle West, refineries located in larger cities paid higher rates for comparable jobs than refineries in smaller communities, and plants employing over 500 workers had a higher wage level than smaller establishments. Nearly all the refineries surveyed had some type of insurance and pension plans, in addition to vacation, sick leave and paid holiday practices.

Reduction of the standard work week from 40 to 36 hours—without any reduction in present take-home pay—is being urged by Oil Workers International Union (CIO) as a means of halting "lay-offs" and spreading employment to avert full impact of a possible depression.

Fourth round pay increase action has been postponed by the OWIU until the next meeting of its Wage Policy Committee, according to union president O. A. Knight. No definite date for the next meeting had been set at that time (May 11), and Knight indicated it might be anywhere from two weeks to two months distant.

• • •

SYNTHETICS

A substitute bill giving Interior Department unquestioned control over the way in which costly synthetic liquid fuels industry would be started with government financial assistance or by government itself has been introduced in Congress by Senator McCarran of Nevada. The new bill was offered as an amendment to the earlier McCarran bill, S. 6. Officials of Interior's Bureau of Mines said the substitute measure has their "whole-hearted" support and that it was worked out recently in a lengthy conference with McCarran.

In addition to giving Interior sole authority to determine locations, raw materials, processes and capacities of any plants constructed under the bill, the measure also would increase the authorized loans from $350 million to $650 million and would be known as the "Synthetic Liquid Fuels Industry Act" (previous measures called it the "Synthetic Liquid Fuels Plant Act").

• • •

MARKETS, PRICES

May saw little change in the trends which oil prices have pursued over the past six months. Gasoline, while in free supply, was relatively firm. But other products, notably heavy fuels, continued to skid. There were sharp cuts in prices for high sulfur, heavy fuel bearing crudes in some areas, and signs that crude prices were easing in other areas as well.

In the Rocky Mountain fields, the larger buyers of

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

crude posted reductions averaging 25c per bbl. in their purchase prices for heavy grades. Michigan crudes were off 22c per bbl. As this is being written, Standard of California announces a further reduction in its prices for heavy crudes, effective June 1.

In posting lower prices for heavy crudes, the announcements of most companies cited the slack demand for heavy fuel oils. One stressed the increase in conversion of railroads from fuel oil-burning to Diesel locomotives.

Top-heavy inventories of both light and heavy fuel oils at refineries were evidenced in the move among major companies on the eastern seaboard to offer buyers "price protection" plans. In heavy fuels, they were in the form of guaranteed tops in contracts for periods extending in some instances to the end of 1950. For heating oils, resellers and consumers will benefit from price reductions between now and the beginning of the heating system on purchases made during the summer months.

In Oklahoma, No. 6 fuel hit a new low of 65c per bbl. At this point, price was 32c under the "ceiling" fixed by OPA during the war. Cargo prices for No. 6 fuel at the Gulf also were off 10c, to $1.15 per bbl. Declines in light fuels were less sharp.

Gasoline prices generally were unchanged. Use of research octane rating gained headway in the Mid-Continent and Midwest, with the majority of companies specifying minimums of 80 for regular grade and 86 for premium. "Jump", or the spread between Motor method rating and Research method rating, is not stressed.

Lube prices in western Pennsylvania appeared already to have discounted another reduction in Penna. Grade crude oil prices posted by leading buyers. A 13c per bbl. cut in the middle of May was the seventh general reduction in prices for this type crude since postwar peaks were reached in December, 1947.

• • •

EXPANSION

Socony-Vacuum Oil Co. will replace Houdry fixed-bed catalytic cracking units at its refineries in Trenton, Mich.; Augusta, Kans., and Beaumont, Texas (Magnolia Petroleum Co., a subsidiary) with four TCC units having total throughput of 60,000 b/d. Two will be installed at Beaumont, and all are expected to be operating by the end of 1950.

Lone Star Gas Co. will modernize and expand its Pueblo plant, close to Cisco, Texas, to increase production of natural gasoline and LPG, using company personnel. An 18-mi., 2-in. line will be built to centralized fractionating facilities at Ranger, Texas, to transport liquids extracted at Pueblo.

Continental Oil Co. will spend $1.5 million to enlarge and modernize its natural gasoline plant near McAllen, Texas. Expected to be operating by year's end, the enlarged plant will produce 5800 gal. of butane and 25,000 gal. of natural gasoline daily, return 8500 Mcf. of gas to formation and sell balance. Gas processing capacity will be 20,000 Mcf. daily.

Deep Rock Oil Corp. has announced plans to completely revamp its Cushing, Okla., plant to include a 5000 b/d Fluid cracking unit, new crude battery, feed preparation unit, heavy oil vis-breaker, gas recovery plant and enlarged poly plant, plus necessary auxiliaries. Contract for Fluid unit, designed by Universal Oil Products, has been awarded to Jones & Laughlin Supply Co.

• • •

NEW PROCESS

Autothermic Cracking is a new process, developed by Universal Oil Products, for reforming propane, naphtha, natural gasoline and other volatile hydrocarbons in admixture with air. Gas companies can find application for the process in meeting peak load demands. Petrochemical manufacturers can use it for cracking ethane, or other available volatile stock, converting it to ethylene.

• • •

TRANSITION

Pan American Refining Co. has purchased General Motor's triptane plant at Detroit. Precise fractionation facilities will be moved to Pan Am's Texas City refinery for incorporation in the plant. Triptane will not be produced.

Denver Producing & Refining Co.'s 2000 b/d skimming plant near Edmond, Okla., has been shut down "for the near future at least" because of inability to move residuum at current prices, company officials say.

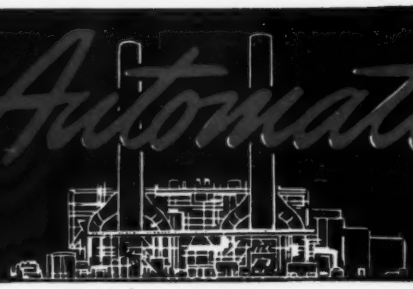
• • •

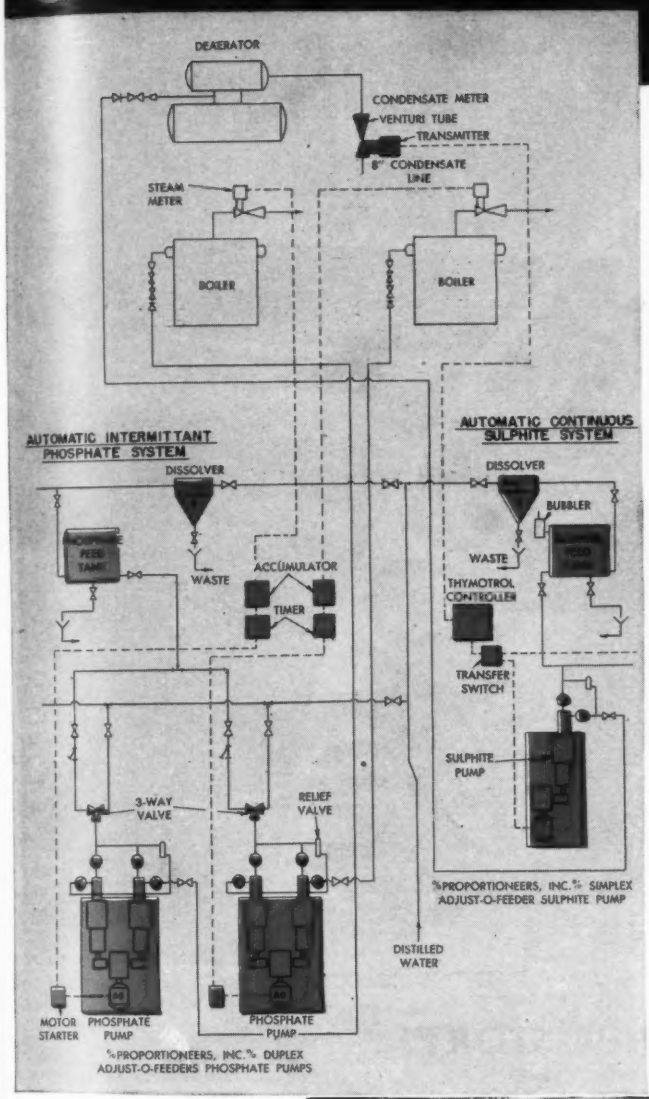
FOREIGN

Dominican Republic has signed a contract with International Industrial Consultants, S.A., for the construction of a $15 million refinery in that country. Location, type and size of plant have not been disclosed as yet, except in a statement that it will be capable of "producing 25,000 bbls. of refined oil daily from imported crude." Lubricants may also be produced.

Anglo American Oil Co. has started construction on the $150 million expansion project at its Frawley, England, refinery. Present 18,000 b/d capacity will be increased to 110,000 b/d. Work will take about three years.

Continuous-Automatic





BOILER WATER CONDITIONING

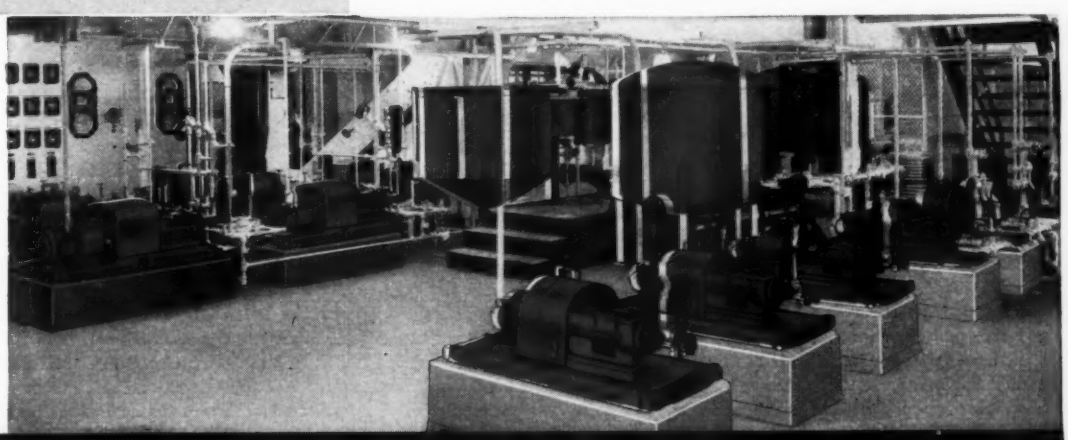
%Proportioneers% boiler water treating equipment was selected for the new Redondo Steam Station of Southern California Edison Co. built by Stone & Webster Engineering Corporation in collaboration with Edison engineers. In this, one of the most modern plants in the world, the boilers are treated automatically and in proportion to their service load. The complete %Proportioneers% system makes chemical treatment a routine procedure, reducing operator responsibility. A necessity in large plants, the %Proportioneers% system is also highly desirable in small plants to reduce manpower and give adequate protection.

We furnish complete feeding systems to engineers' specifications or, where required, can adapt our controls to existing equipment. Ask for Brochure SM 122 "Treatment of Water for Boilers".

All equipment shown red in photo and flowgram furnished by %Proportioneers, Inc.%

%Proportioneers% sulphite feed pumps in the Redondo Steam Station, in foreground; high pressure duplex phosphate pumps and control panel, in the background.

No. 3 in a series on boiler water conditioning.



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Write to %Proportioneers, Inc.%, 48 Codding St., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

N.B.

While it is axiomatic that return on investment—the *ultimate earning power* of a refinery unit when actually on stream—is the only true evaluation of competitive engineering recommendations, initial plant costs remain a major factor in refiners' decisions on plant installations. M. W. Kellogg takes specific steps to *minimize initial plant costs* consistent with the achievement of *highest ultimate earning power.*

A THREE-WAY PIPE STORY!

Consider for a moment that piping accounts for about one quarter of the cost of the average installation.

That can put piping in the million and often multi-million dollar class. If savings of from 10 to 20% can be effected, refiners will realize important economies, particularly attractive in these days of high costs.

Of course, accurately computing specific savings on a piping job is virtually impossible. There are too many variables. But Kellogg today estimates that its methods of field fabricating lop upwards of 15% off the cost of refinery piping work.

Here's why.

First, pipe is bent on the site as needed. No waiting for key pieces to arrive. Even one day saved over the course of the entire job represents a sizable sum both in labor savings and in the refiner's operating revenue.

Second, the shop overhead of the plant where such pipe would normally be fabricated, is dispensed with entirely.

Third, Kellogg's own crews handle the piping fabrication in the field, hiring necessary supplementary craft labor on an hourly basis. Thus there are no sub-contractors' fees pyramiding on the cost of the job.

There are still other advantages such as savings in shipping straight pipe rather than space-consuming, odd shapes, and they all add up to money in the bank for the owner.

Kellogg's development of field fabricating techniques sounds rather obvious and certainly simple when explained this way—but it wasn't. The move required that shop equipment be duplicated in mobile form, that shop techniques and quality standards be duplicated under field conditions subject to both the weather and the physical idiosyncracies of each job site.

Such an operation as this is only possible when backed, organized and controlled by a *complete* organization—such as that of M. W. Kellogg—where all types of specialists are available for handling the myriad problems involved. These savings effected in field fabrication of piping provide further proof that *completeness and integration of the engineer-contractor* are the keys to LOW INITIAL PLANT COST.

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Tomorrow

. . . IN PETROLEUM TECHNOLOGY

By B. H. WEIL, Atlanta, Ga.
Editor, "Monthly Summary of Industrial Developments"

Brief reviews of currently reported technological and economic developments, in the light of their potential bearing on petroleum refining

New Data on Properties of Railroad Diesel Fuels

VALUABLE INFORMATION for the refiners of Diesel fuel oils may be forthcoming from a long-time study of the relationship of Diesel fuel properties and engine design to Diesel combustion being carried on by the Electro-Motive Division of General Motors Corp. A progress report on the work has already been presented.(1)

The research project originated from difficulties experienced during the war with a railroad Diesel fuel of lower quality than had previously been considered minimum. Many Diesel engines suffered a high rate of piston ring breakage which was associated with fuel characteristics. Co-operative tests made by one oil company supplier and Electro-Motive indicated that the rate of pressure rise in the test engine cylinder was high with fuel causing piston ring breakage in the field and that this rate of pressure rise seemed to follow the cetane number of the fuel.

As a result of the early test work the fuel injector and the injection characteristics of the test engine were re-designed to reduce the shock caused by lower cetane fuels and also to reduce maximum cylinder loading. Subsequent tests with the re-designed injectors indicated that appreciable improvement in fuel economy had also been achieved.

A more detailed study with commercial type fuels, using the new injector, indicated that for the wide variety of fuels tested, cetane number and heating value are the two fuel properties which control the cylinder pressure characteristics of the GM 567 railroad Diesel engine. The former applies only for non-additive fuels.

"For rated load railroad conditions the thermal efficiency of the engine is constant, so the railroad customer will get the most for his money by buying the heaviest fuel compatible with maintenance cost. Specific fuel consumption by weight is not an indication of the efficiency with which the engine burns fuel."

(1) "A Railroad Diesel Engine Improvement Based on Study of Combustion Phenomena and Diesel Fuel Properties," by H. W. Barth, F. A. Robbins, and H. C. Lafferty, Electro-Motive Division, General Motors Corp.; presented at National Tractor and Diesel Engine Meeting, Society of Automotive Engineers, Milwaukee, Sept. 7-9, 1949.

Aromatics from Petroleum Face Economic Hurdles

THE MYSTIC HAZE which for a time threatened to obscure the facts concerning the production of chemicals from petroleum seems lately to have lifted, and all concerned now soberly weigh the pros and cons before venturing enthusiastic predictions or pessimistic observations regarding new developments. This is certainly true as regards the economics of the production from petroleum of the aromatic hydrocarbons—benzene, toluene, the xylenes, naphthalene, etc.—as a recent article(2) bears testimony.

These "coal-tar chemicals" (for so they used to be classified) have been in heavy demand now for a number of years, and domestic sources of production from coal have fallen far short of the mark. Toluene supplies, as is well known, have been heavily augmented by production from petroleum (largely by hydroforming C_7 cuts, then extraction), and xylene supplies have been aided by the same method (with *o*-xylene used as a substitute to relieve the naphthalene shortage to some extent). However, benzene and naphthalene are not found in petroleum fractions (natural or processed) to a commercially extractable extent, and the economics of such high-temperature aromatization processes as that currently being employed in England by Petrochemicals, Ltd., to produce liquid products in yields of 36-54%, containing up to 95% of aromatic hydrocarbons, have never been clearly determined.

John M. Weiss, in his recent survey, arrives at no clear-cut solution to the problem. As he points out, increased imports are unlikely in view of growing foreign demands for these very chemicals. Moreover, production from petroleum is fraught with complex aspects. For example, Weiss points to the fact that, while *o*-xylene may readily be extracted from hydroformates, its cost depends upon whether the toluene also extracted has a ready market, whether the *m*-*p*-xylene also extracted can be sold as a solvent or must be returned to the fuel at gasoline value, and whether or not the mixed xylenes could be more profitably sold for solvent purposes without extracting the small quantity of *o*-xylene. Moreover (although unlikely in the near future), a 25% drop in tetraethyl lead prices would render hydroforming unprofitable, eliminating the common petroleum source for *o*-xylene.

Weiss does point to the increased use of cyclohexane (extracted from petroleum naphthas) as a substitute for benzene for such processes as nylon synthesis and to the possibility that prices for benzene and naphthalene might rise to the point where synthesis or extraction from petroleum might be profitable. Moreover (although here he is probably quite futuristic), he dwells at some length on the by-production of aromatic-containing tars from synthesis gas production from coal for use in the Synthine (Fischer-Tropsch) process.

(2) John M. Weiss, "Possible Future Sources of Aromatic Hydrocarbons," *Chemical and Engineering News* 27, No. 14, 972-74 (1949).

Hydrogen Fluoride Tried As Desulfurization Solvent

VARIOUS AUTHORITIES among the oil companies have reported recently on research work on the possible use of hydrogen fluoride as a solvent medium for the extraction of sulfur compounds from petroleum oils, which may have an important bearing on this common refining problem.

The work done on this subject in the research laboratories of Standard Oil Co. (Indiana) has progressed to the pilot plant stage, or at least the planning for it, it was brought out in a talk given by J. K. Roberts, general manager of research for the company.(3) He used the HF desulfurization project as an example of the complex nature of the research problems now posed for the refining companies. He described the special design of a three story pilot

(3) Talk by J. K. Roberts, general manager of research, Standard Oil Co. (Indiana), before the Kentucky chapter of Sigma Xi, University of Kentucky, Lexington, May 5, 1949.

plant where the HF solvent extraction operation would be carried out. In another pilot plant, various types of sulfur feed stock will be prepared for HF solvent extraction.

By means of the pilot plant work, data will be obtained to permit the chemical engineering group to work out a process design for a commercial unit, and this data is used by the mechanical engineers in estimating the cost of a commercial unit. "With this information, the economics group can for the first time make an accurate comparison of the HF process with other desulfurization processes. It may turn out that HF extraction is more expensive and we might as well forget all about it. However, if we should find a saving in processing costs of even a hundredth cent a pound, this would correspond to $1300 a day in the operation of a 42,000 b/d plant".

Ought the HF extraction process to be used on the gasoline or on the gas oil from which a large part of the gasoline is made, is one important question being studied.

Preliminary work in the studies of this company with HF for solvent extraction of sulfur compounds was also reported on at the recent meeting of the Petroleum Chemistry Division of the American Chemical Society in San Francisco.(4) A total of 16 aliphatic sulfur compounds were investigated in a study of the action of anhydrous HF toward individual sulfur compounds in hydrocarbon solutions.

"The extraction of organic sulfur compounds with anhydrous liquid HF shows an orderly progression with changes in molecular weight, configuration of alkyl group or type of sulfur compound. Besides extraction, certain sulfur compounds undergo intra- and inter-molecular reactions in the presence of hydrogen fluoride. With difficult extractible mercaptans, addition of olefins results in the formation of thioethers soluble in HF and thereby markedly enhances the degree of extraction.

"These findings, in addition to their theoretical interest, have important applications to the extraction of sulfur compounds from petroleum."

At the same ACS meeting(5) research work on the desulfurization properties of HF done by the California Research Corp. (Standard of California) was reported. It was found that the amount of desulfurization produced by treating various stocks with a given amount of HF varied to a large degree. To secure a basic understanding of the reaction, it was decided to treat olefin-free hydrocarbon solutions of pure sulfur compounds with hydrofluoric acid.

As a result of this work sulfur compounds were divided into three groups with regard to the selectivity of HF for their removal: Small or no selectivity- elementary sulfur and dibenzothiophene; medium selectivity-carbonyl sulfide, disulfides and mercaptans with mercaptan selectivity somewhat greater than disulfide selectivity; large selectivity-sulfides and alkylthiophenes.

(4) "Extraction of Sulfur Compounds with Hydrogen Fluoride," by A. P. Lien, D. A. MacCauley, and B. L. Evering, Research Laboratories of Standard Oil Co. (Indiana); presented before Symposium on Organic Sulfur Compounds, Division of Petroleum Chemistry of the American Chemical Society, San Francisco, March 27-April 1, 1949.

(5) "Action of Hydrofluoric Acid on Hydrocarbon Solutions of Sulfur Compounds," by R. E. Barieau and M. R. Barusch, California Research Corp.; presented before Symposium on Organic Sulfur Compounds, Division of Petroleum Chemistry of the American Chemical Society, San Francisco, March 27-April 1, 1949.

Hydrocarbon Chlorination Now Chief Source of HCl

THE PETROLEUM INDUSTRY, by now, is quite accustomed to producing valuable by-products from operations designed for quite a different purpose. Such by-products often dominate fields in which the industry previously took little part. Potential Synthine plants, for example, will control market conditions for many oxygenated hydrocarbons because of the oxygenated chemicals to be produced therein as by-products.

It is, therefore, interesting to note that it has been estimated(6) that 35 to 50% of all hydrochloric acid produced in 1948 came as a by-product from the chlorination of hydrocarbons, "especially by petroleum companies," and that the long-term outlook indicates a steady growth in production from this source, although, "with the return of a buyer's market, the rate of rise of the multitude of chlorinated compounds will probably be curtailed as competition grows."

At present, however, "half a hundred companies with 74 plants turn out hydrochloric acid at a combined rate of nearly a ton a minute." Among these companies are Carbide and Carbon, Celanese, Dow, du Pont, the Ethyl Corp., Frontier Chemical, Heyden Chemical, Koppers, Monsanto, Sharples Chemicals, Solvay, and U. S. Industrial Chemicals.

So much by-product hydrochloric acid is available in some areas, indeed, that this, combined with "current shortages of chlorine, have induced considerable research and patents on methods of reconverting hydrochloric acid back into chlorine," the reverse of one of the direct processes now in use for hydrochloric acid production.

(6) A. J. P. Wilson and R. F. Warren, "Hydrochloric Acid," *Chemical Engineering* 56, No. 4, 305-06 (1949).

Chemicals from petroleum—"petrochemicals," to the nonpurist—do not have to be organic in nature, as witnessed by production from petroleum of hydrogen, hydrochloric acid, hydrogen sulfide, and sulfur.

DDT Insecticides Facing Possible Public Disfavor

SOME DEGREE OF PUBLIC DISFAVOR may now be threatening the DDT insecticides, despite long-term herculean efforts on the part of manufacturers (petroleum companies and others) to forestall this very thing. All those who manufacture DDT-containing products have long been aware of the toxicity of their base material (DDT), and reputable insecticide producers have printed proper instructions and due warnings on the labels of their packages and have leaned over backwards to keep DDT concentrations within reasonable limits.

However, recent studies which described the deleterious effects of traces of DDT in the domestic milk supply have evoked considerable publicity of an adverse nature in the technical and popular press. It seems that these DDT traces get into the milk through absorption by cows of DDT insecticides sprayed on them, on their feed, and used as a residual spray in dairy barns. The Department of Agriculture has notified insecticide manufacturers not to recommend DDT sprays for these purposes and has advised farmers not to use them.

Other insecticides may be substituted for DDT for the uses in question, without undue expense or appreciable diminution of insecticide quality, but there is danger that the "DDT scare" may affect the sale of DDT insecticides for other and still-suitable purposes, since the public was apparently not awake to the dangers of using such insecticides improperly, despite adequate warnings on package labels.

The insecticide market is one in which manufacturers have their headaches without this new problem. Naphtha-base sprays must compete with the popular (but more expensive) aerosol bombs, and so many are the brands on the market that it is a moot question whether many companies are making much money. In any case, the present DDT scare serves to point to the value of toxicity evaluations of products and to the necessity of putting across to users, without undue "fright," the information so obtained. How to do the latter successfully is apparently quite a trick.

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When you add Santopoid 29 to suitable base stocks, your gear lubricants retain all their fine qualities and take on others necessary to please customers and increase sales. Santopoid 29 enables you to make one lubricant suitable for transmissions and differentials of trucks and passenger cars.

It is extremely easy to add Santopoid 29 to your lubricants. Pre-blending is unnecessary. You can use conventional equipment and normal blending temperatures. Santopoid 29 does not separate or stratify in lubricants.

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Motorists are pleased with the results of lubricants containing Santopoid 29. Such lubricants make gears last longer.

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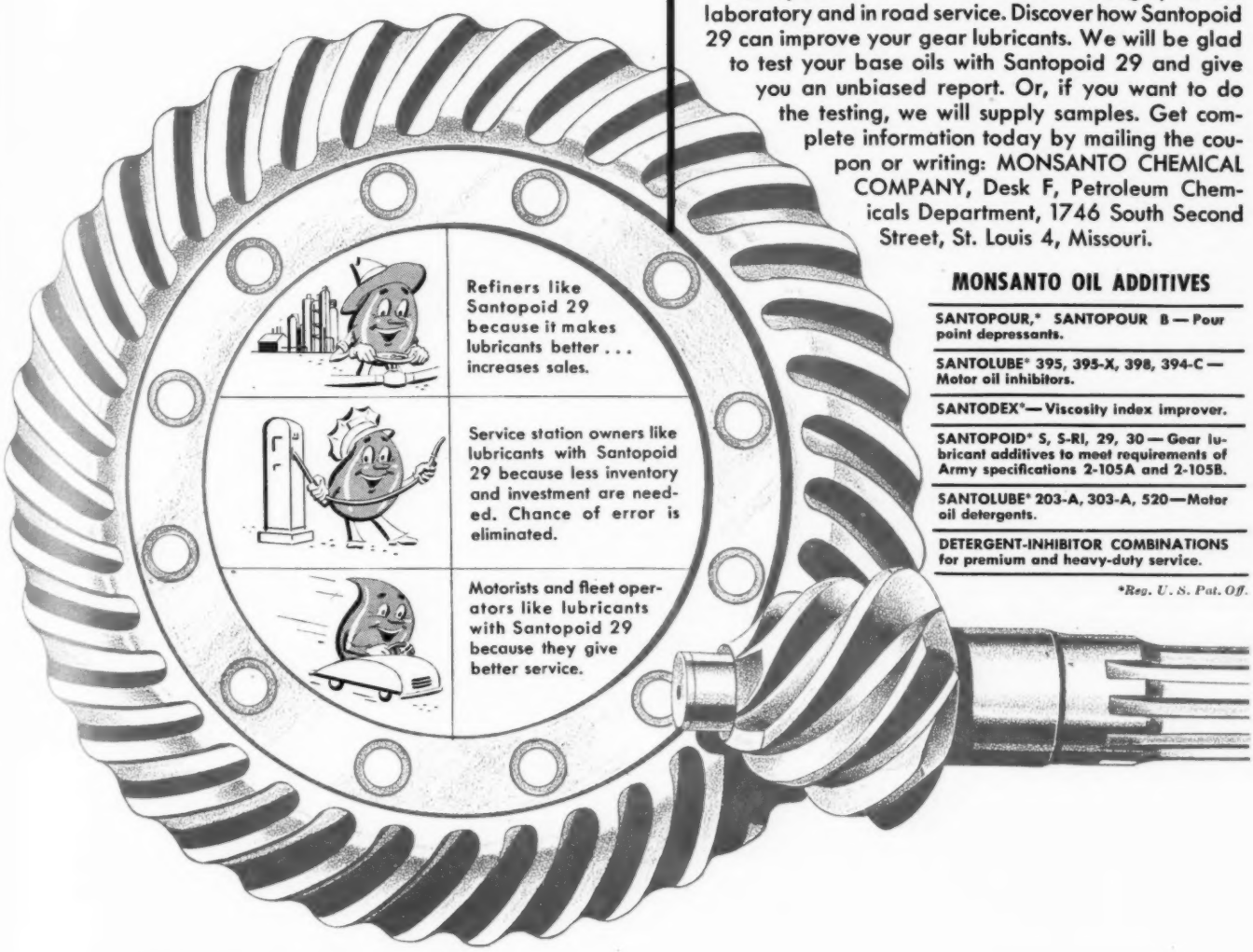
Refiners like Santopoid 29 because it makes lubricants better . . . increases sales.
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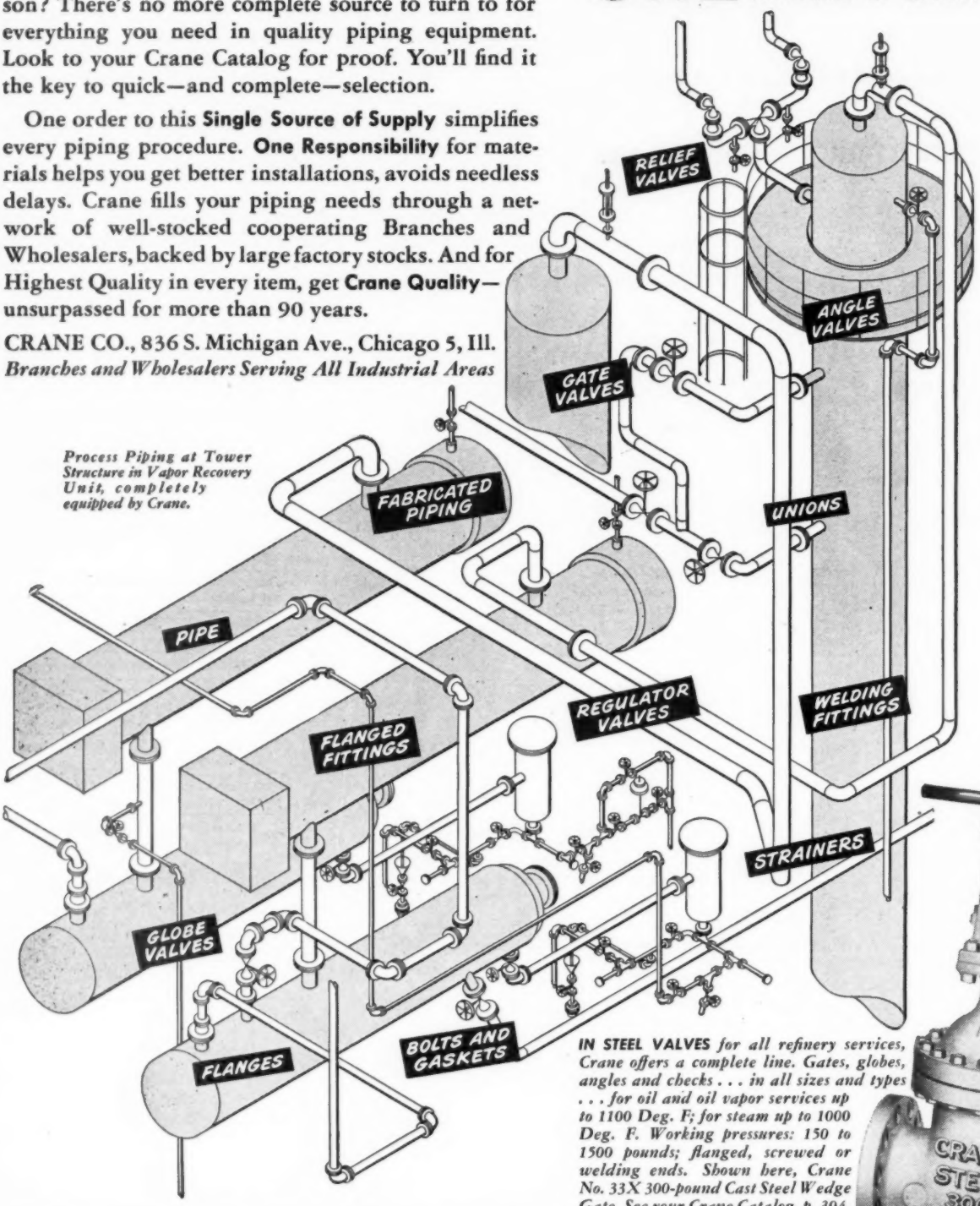
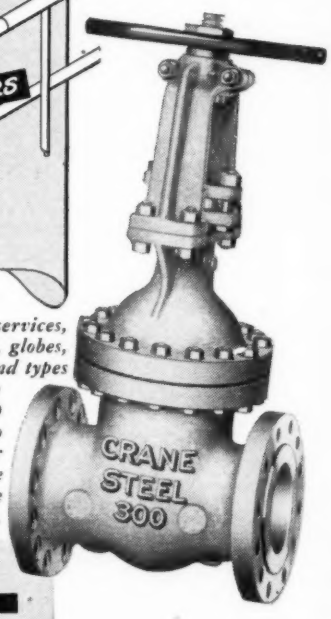


Process Piping at Tower Structure in Vapor Recovery Unit, completely equipped by Crane.



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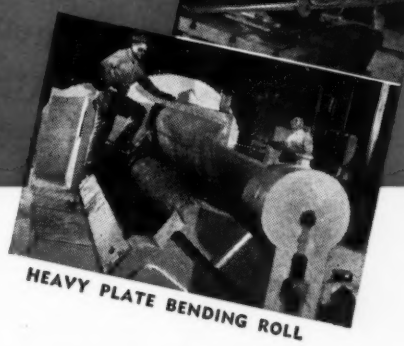

HEAVY PLATE BENDING ROLL

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Engineering and design is an important part of the services offered. Experienced engineers and draftsmen, as well as shop and fabricating personnel, are available, with modern facilities to carry out such programs.

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- 7′ x 7′ x 40′ ANNEALING FURNACE
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- X-RAY EQUIPMENT FOR PLATE UP TO 20″ THICK

The new plant, of more than 5 acres under one roof, is across the street from the present National Tank manufacturing site. *Inquiries for quick delivery are invited.*

It's a National

A color brochure has been prepared describing in detail this new plant, which is located on a 36½-acre site. For your copy, please write

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Fact File on Preheat

No. 3

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All the characteristics of the Ljungstrom's rotating heat-transfer unit—its surface area, size and shape of passages, and counter-flow arrangement—act to obtain maximum heat recovery for the unit's size and weight.

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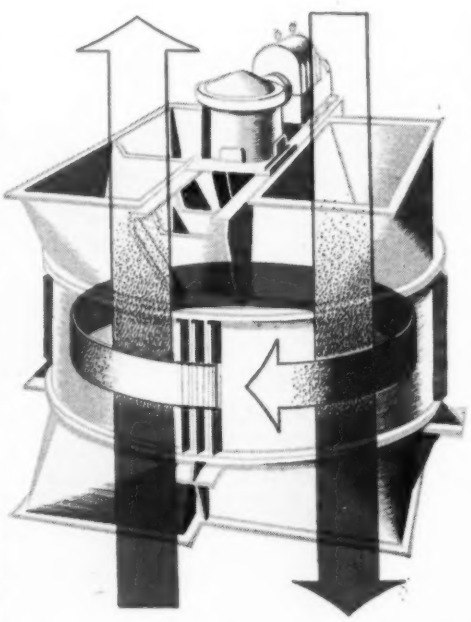

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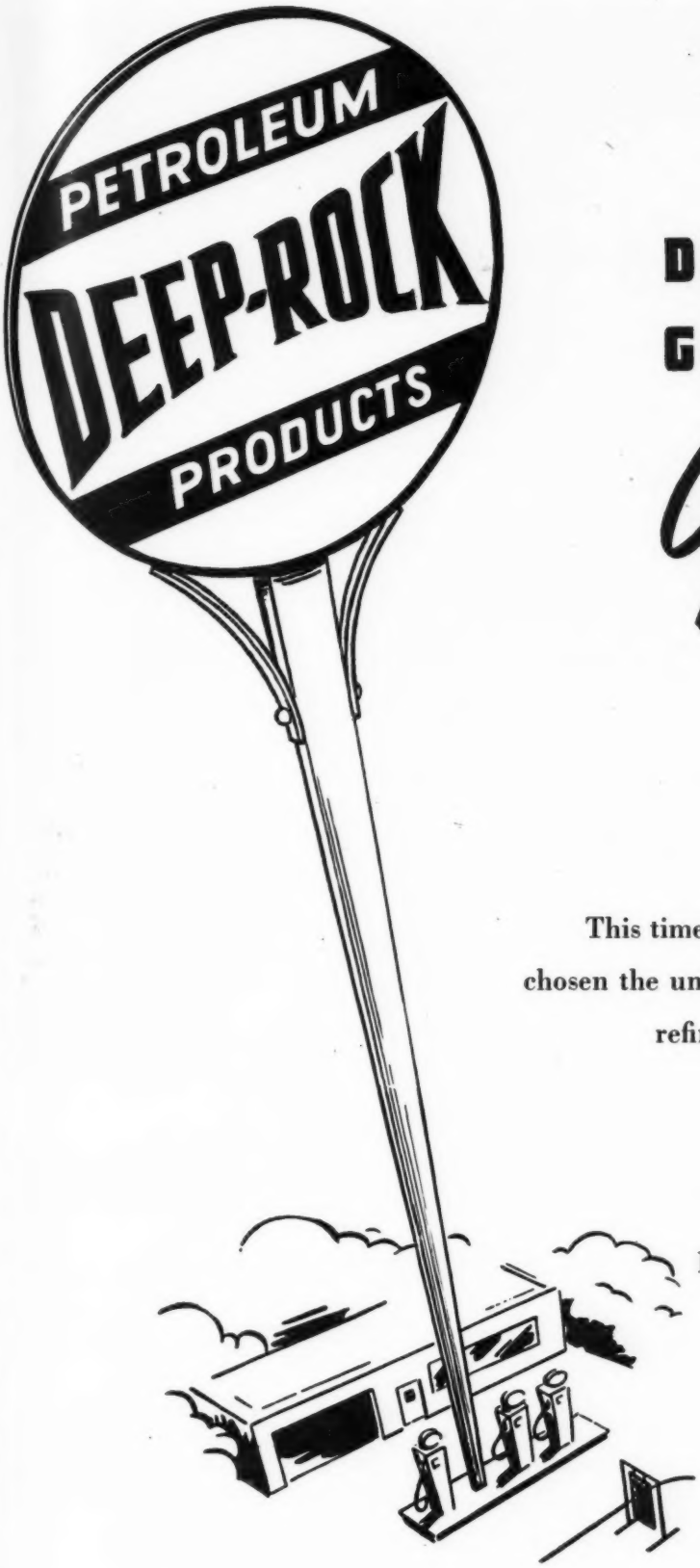

DEEP ROCK GOES *Fluid*

One more progressive refiner considers plant improvement and specifies the UOP Improved Fluid Catalytic Cracking Unit.

This time it is the Deep Rock Oil Corporation who have chosen the unit for installation at their Cushing, Oklahoma, refinery. The unit will be licensed and engineered by Universal, while the overall refinery engineering and construction will be handled by Jones and Laughlin Supply Company.

Deep Rock's decision is continuing evidence of the preference among progressive refiners for the UOP Fluid design . . . a preference based on the proved advantages of simplicity, flexibility, economy, maximum liquid yield and higher product quality.

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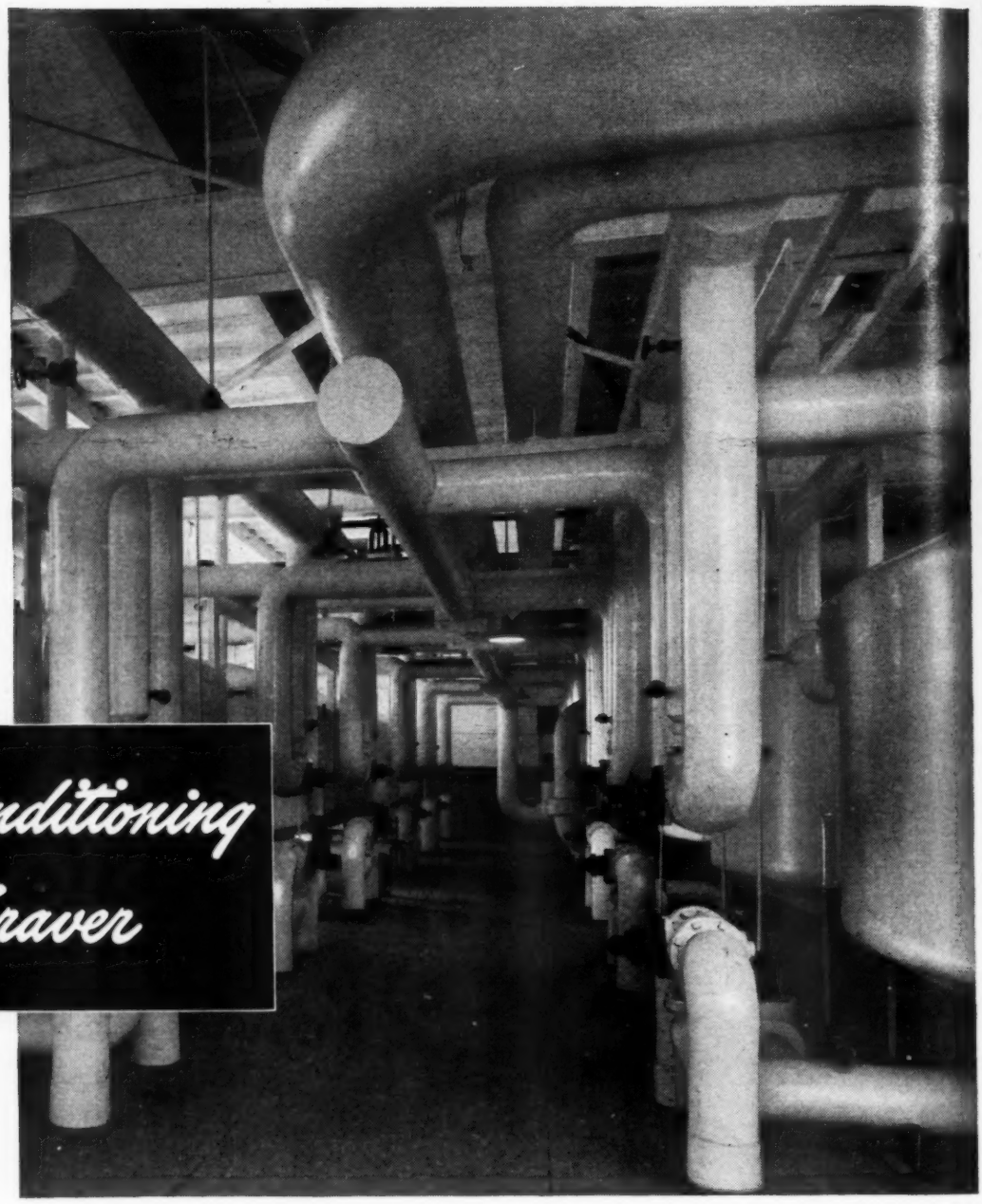
Universal Service Protects Your Refinery



Water Conditioning by Graver

PRESSURE WATER FILTERS—A PART OF THE COMPLETE GRAVER LINE

Water filters *may* be the solution to your water conditioning problem. If they are, Graver engineers will recommend their installation. But, if another type or a combination of equipment will meet your requirements more efficiently, more economically, then Graver engineers will recommend that type.

The Graver line is complete. It includes all types of water conditioning equipment . . . Reactivators, hot process softeners, zeolite softeners, demineralizers, deaerators, condensate conditioners, plus the various combinations of these types that specific conditioning problems demand.

Avoid the danger of installing the wrong equipment. Call in a Graver engineer today. Get a sound, impartial recommendation. There's no obligation.

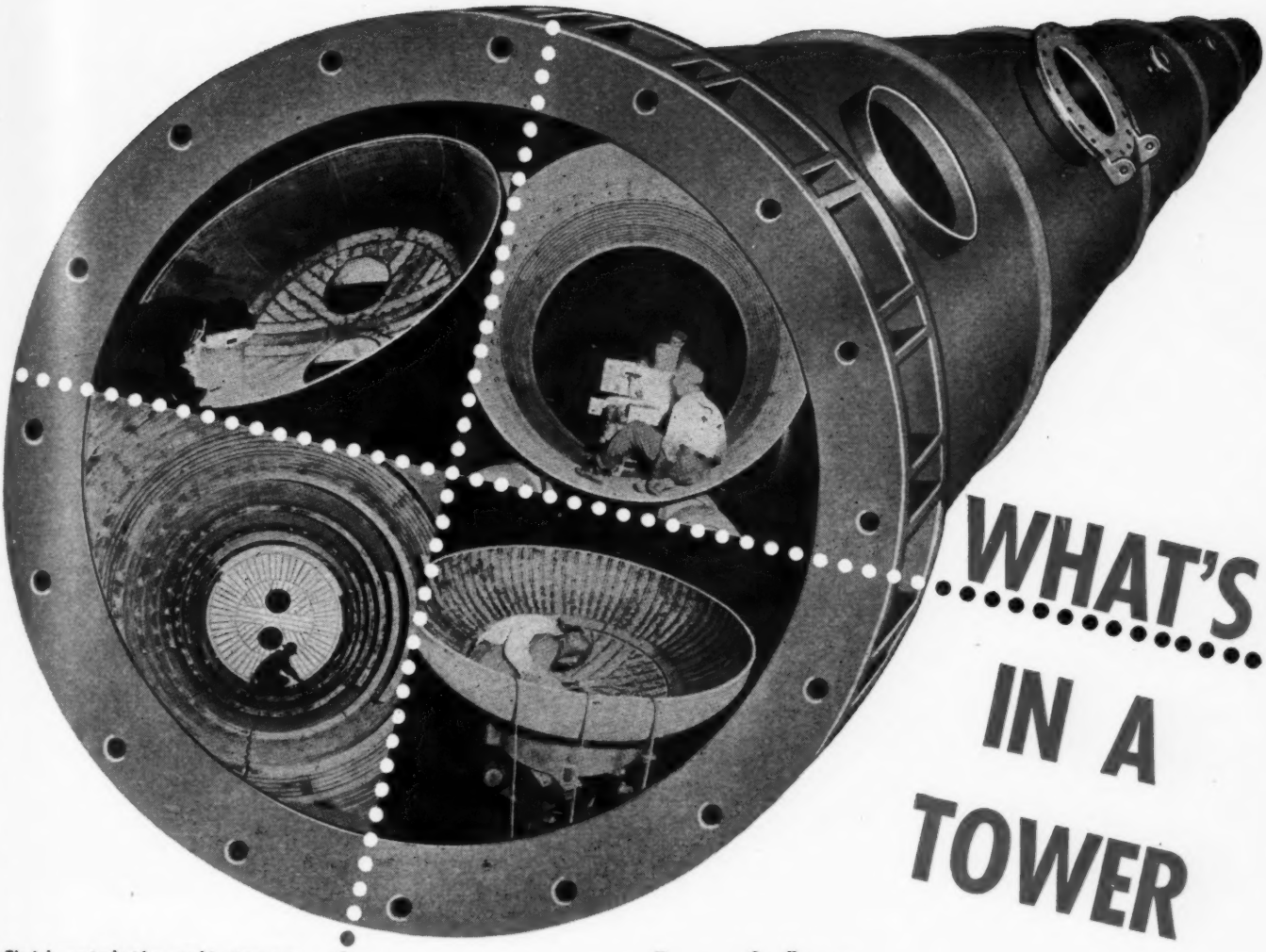
GRAVER

WATER CONDITIONING & PROCESS EQUIPMENT DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.



WHAT'S IN A TOWER

Fluid catalytic unit tower 8'0" ID x 50'0" 5/8" steel shell, clad with 12 gauge stainless steel strips, complete with tray supports...Nooter fabricated to Universal Oil Products Co. design.

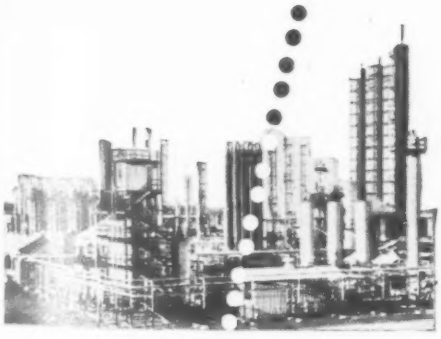
besides design and metal?

Well, for one thing: Over one mile of Nooter *DuraPure* Welding. The continuous automatic and manual arc-welded construction surpasses API-ASME Code specifications. . . Uniform bond achieves high strength, and surface purity of welds maintains corrosion-resistance. Stress-relieving insures safety and precise, undistorted alignment.

After being cross-checked for precision fit-up the vessel was shipped on schedule — ready for erection.

This is why Nooter-fabricated equipment is competently serving the petroleum industry throughout the world.

When your blue prints are ready — call in Nooter!



NOOTER

Nooter Catalog, complete with corrosion data charts is sent at your request.

JOHN NOOTER BOILER WORKS CO. • 1459 South Second St. • St. Louis 4, Mo.

You know it's a tight seal

When you operate a Nordstrom valve you don't have to battle with it. Simple slideable rotary action replaces wedging, jamming and forcing. You can open or close a Nordstrom in a matter of seconds. You don't have to guess whether or not the valve is seated—it's always seated. The effective life of Nordstrom valves is so extended that they cost less in point of service rendered—a fact proved by any comparison.

KEEP UPKEEP DOWN—*Use only genuine Nordcoseal lubricants*

Let's get back to fundamentals

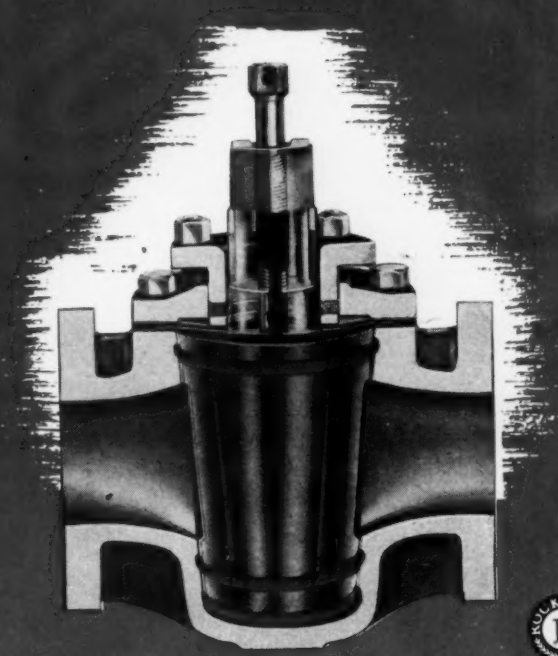
THE PURPOSE OF A VALVE IS TO SHUT OFF A LINE

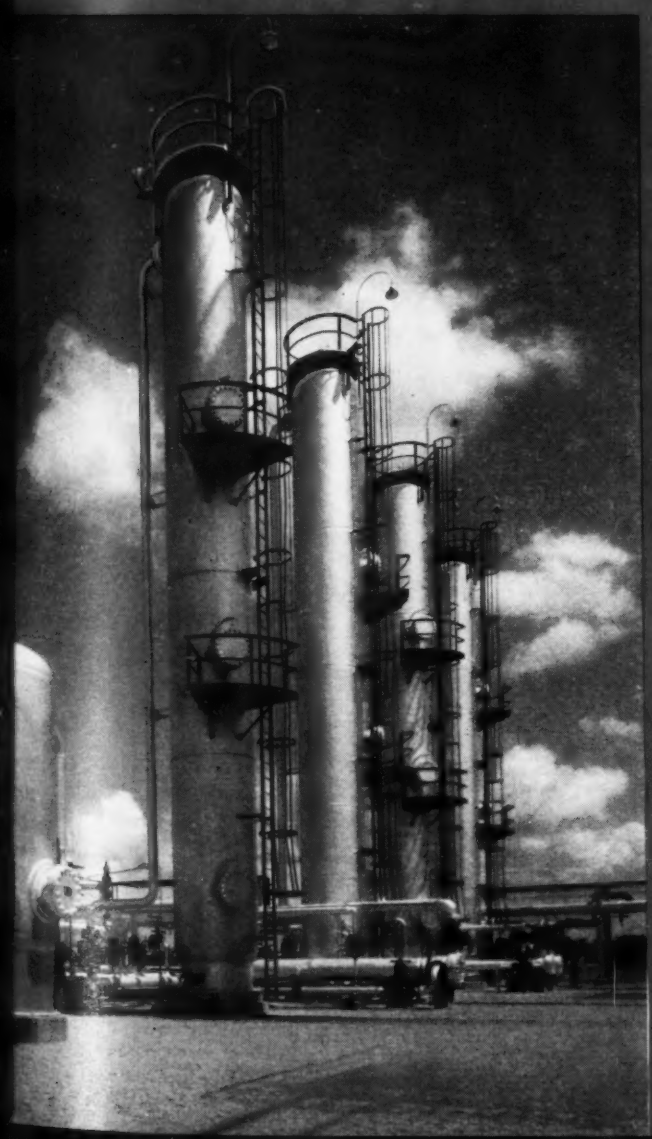
On the premise that a good valve should be a dependable shut-off first, last and always, how is this objective best accomplished? *You want a valve that is leak-resistant.* Instead of depending upon the tightness of a wedged closure to block the line fluid, Nordstrom provides a pressurized plastic seal around each port, renewable at will by a few strokes of a grease-gun, or by turning a lubricant screw. It's that simple.

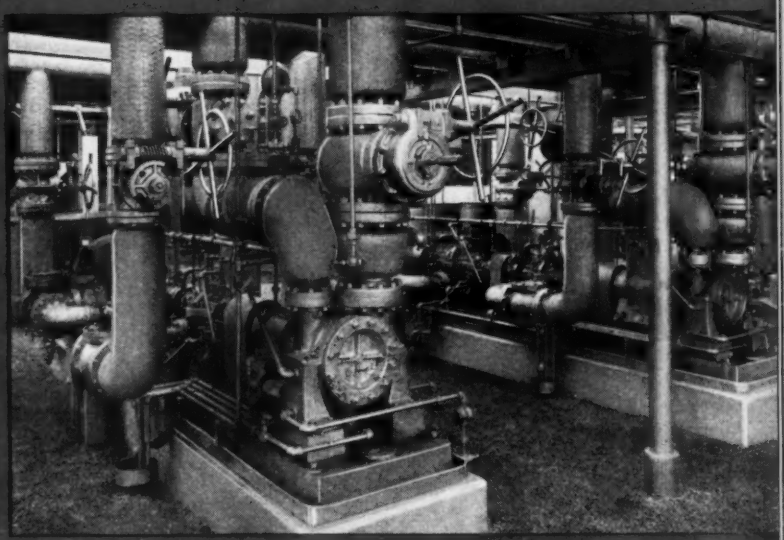
You want a valve that doesn't stick. Nordstrom makes every turn an easy one because the slideable surface of the tapered plug is lubricated and the plug is lubricant-jacked to keep it free-turning. Admittedly, a lubricated surface is superior to a dry metal-to-metal contact.

You want a valve that is long lasting. Nordstrom prevents undue wear of the seat by never exposing it to the line. Lubricant between plug and seat supplies a protective film.

In all phases of petroleum processing, Nordstrom valves stand up to extreme conditions such as hydrocarbons combined with high temperatures, corrosive chemicals and abrasives.







All sizes for all pressures

Nordstrom
LUBRICATED VALVES

NORDSTROM VALVE DIVISION - *Rockwell Manufacturing Company*

400 North Lexington Ave., Pittsburgh 8, Pa.

Atlanta, Boston, Chicago, Houston, Kansas City, Los Angeles, New York, Pittsburgh
San Francisco, Seattle, Tulsa . . . and leading Supply Houses.
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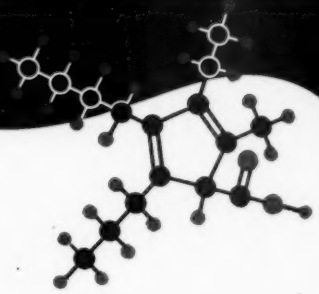
aluminum protects...

PROTECTS THESE SUSCEPTIBLE CHARACTERS



Sensitive fats and fatty acids and aldehydes tend to oxidize and decompose. This is why forward-thinking process chemists are planning more and more Alcoa Aluminum Tanks, Pipes, Fittings and Condensers. Stability, taste, odor and appearance are safe in Alcoa Aluminum.

Alcoa Aluminum won't promote oxidation of fats and oils; is nonsparking. Its corrosion products are colorless, tasteless, harmless. Alcoa Aluminum equipment is easy to fabricate and erect.

Alcoa's Development Division wants to answer your questions and show you results of their research along these lines. We will help develop your process equipment and pilot plants for both chemical and petrochemical processes. Call your nearby Alcoa Sales Office or write ALUMINUM COMPANY OF AMERICA, 1784 Gulf Building, Pittsburgh 19, Pennsylvania.

Visit Our Booth:
National Chemical Exposition,
Grand Central Palace, New York City
November 28—December 3

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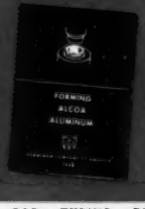
welding



forming

heat exchanger tubes

alloys

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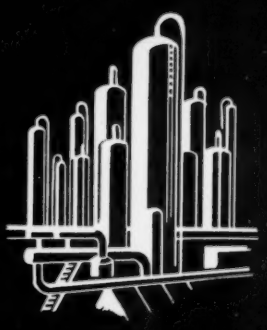
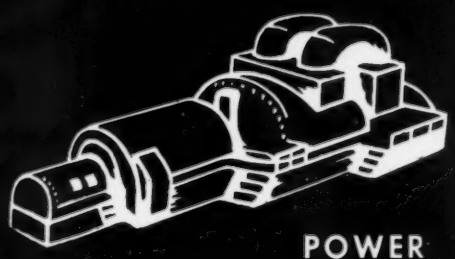
LOWER HEAD LOSS

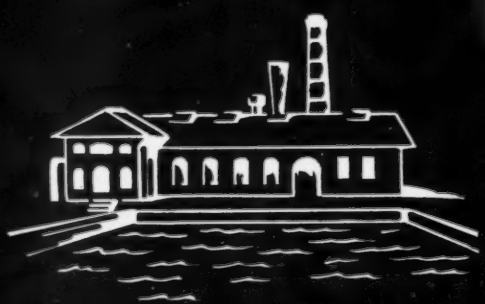
CHEMICAL



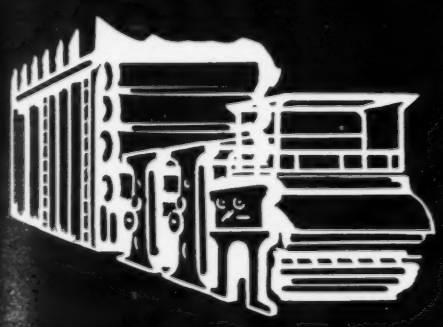
PETROLEUM



POWER



WATER WORKS



PAPER

NEW BETHLEHEM FLOW TUBE*

SIMPLIFIES PETROLEUM FLOWMETERING

Here's the new primary device that's simplifying rate-of-flow measurement of petroleum products in refineries, pumping stations, tank farms and bulk plants across the country—the Bethlehem Flow Tube.

The Bethlehem Flow Tube is adaptable to any and all flow measuring instruments . . . gases or liquids. Normally less than one pipe diameter in length, it is easy to apply . . . inexpensive to install. Symmetrical construction permits measurement of flow in either direction. With negligible resistance to flow and freedom from most straight run limitations, the Bethlehem Flow Tube is the answer to a long-needed improvement in flow primary devices.

Find out how this new primary element can cut your metering costs . . . give you greater accuracy . . . now! Write for the folder "Bethlehem Flow Tube."

*Gentile Patents—Pat. No. 2,260,019. Other patents pending.

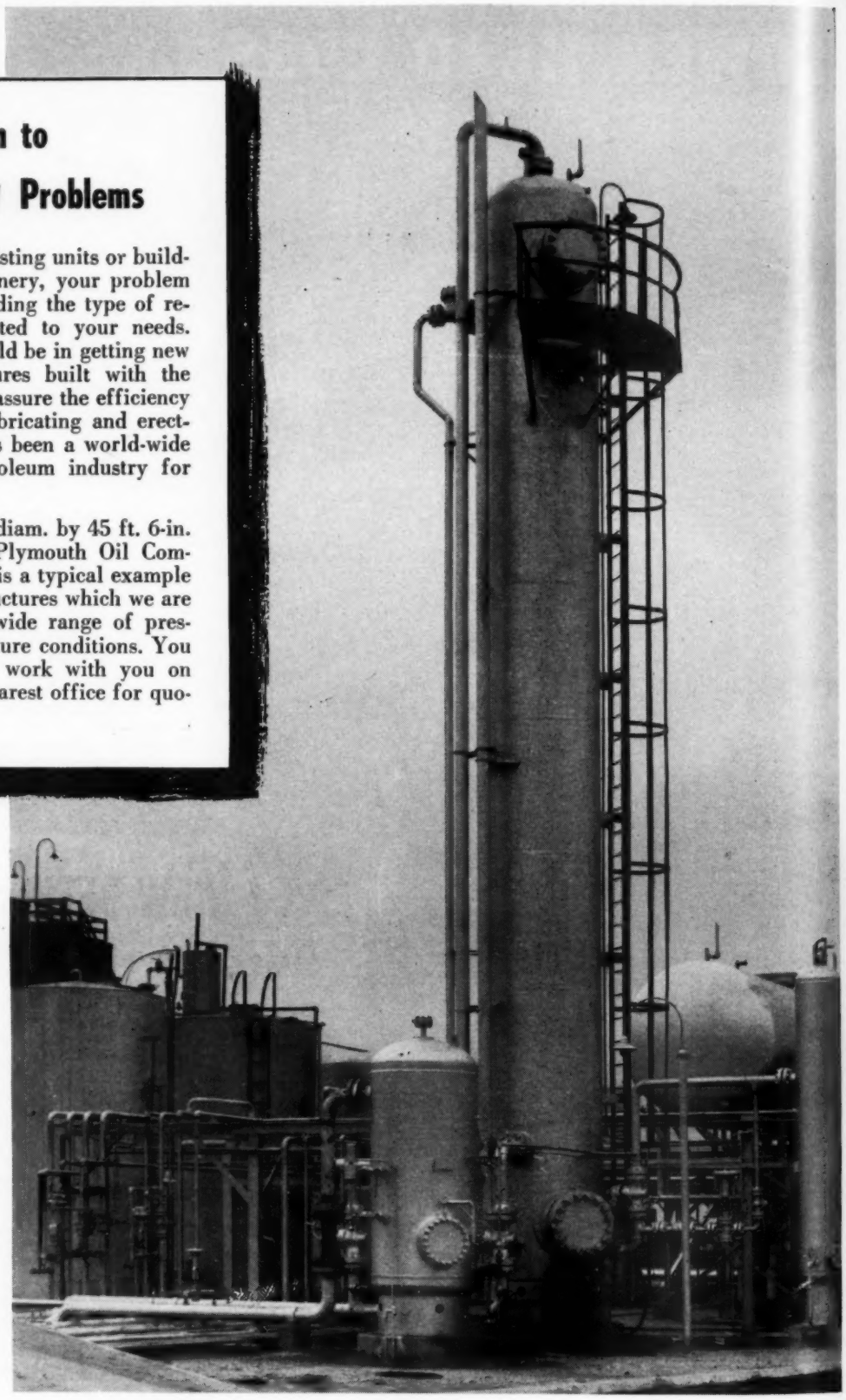
BETHLEHEM FOUNDRY

& MACHINE COMPANY • BETHLEHEM • PENNA.

An Efficient Solution to *towering* Problems

Whether modernizing existing units or building a completely new refinery, your problem is bigger than simply deciding the type of refinery equipment best suited to your needs. Your greatest concern should be in getting new welded steel plate structures built with the engineering skill that will assure the efficiency you desire. Designing, fabricating and erecting refinery equipment has been a world-wide CB&I service to the petroleum industry for many years.

We built this 4 ft. 6-in. diam. by 45 ft. 6-in. absorber column for the Plymouth Oil Company at Sinton, Texas. It is a typical example of the many steel plate structures which we are equipped to build for a wide range of pressure, vacuum and temperature conditions. You will profit by having us work with you on your next job. Ask our nearest office for quotations.



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Depropanizer Towers
Debutanizer Columns
Regenerator Towers
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Refinery Drums
Pressure Cylinders
Vacuum Flashers
Vacuum Stills
Cracking Chambers
Catalytic Towers

...to meet modern refinery specifications

CHICAGO BRIDGE & IRON COMPANY

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Boston 10 .....1029–201 Devonshire Street
Chicago 4 .....2114 McCormick Building
Cleveland 15 .....2215 Guildhall Building
Detroit 26 .....1532 Lafayette Building
Houston 2 ....2130 National Standard Building
Havana .....402 Abreu Building
Los Angeles 14 .1526 General Petroleum Building
New York 6 ....3310–165 Broadway Building
Philadelphia 3 ..1630–1700 Walnut St. Building
Salt Lake City 1 1530 1st Security Bank Building
San Francisco 11 ..1208–22 Battery St. Building
Seattle 1.....1330 Henry Building
Tulsa 3 .....1620 Hunt Building

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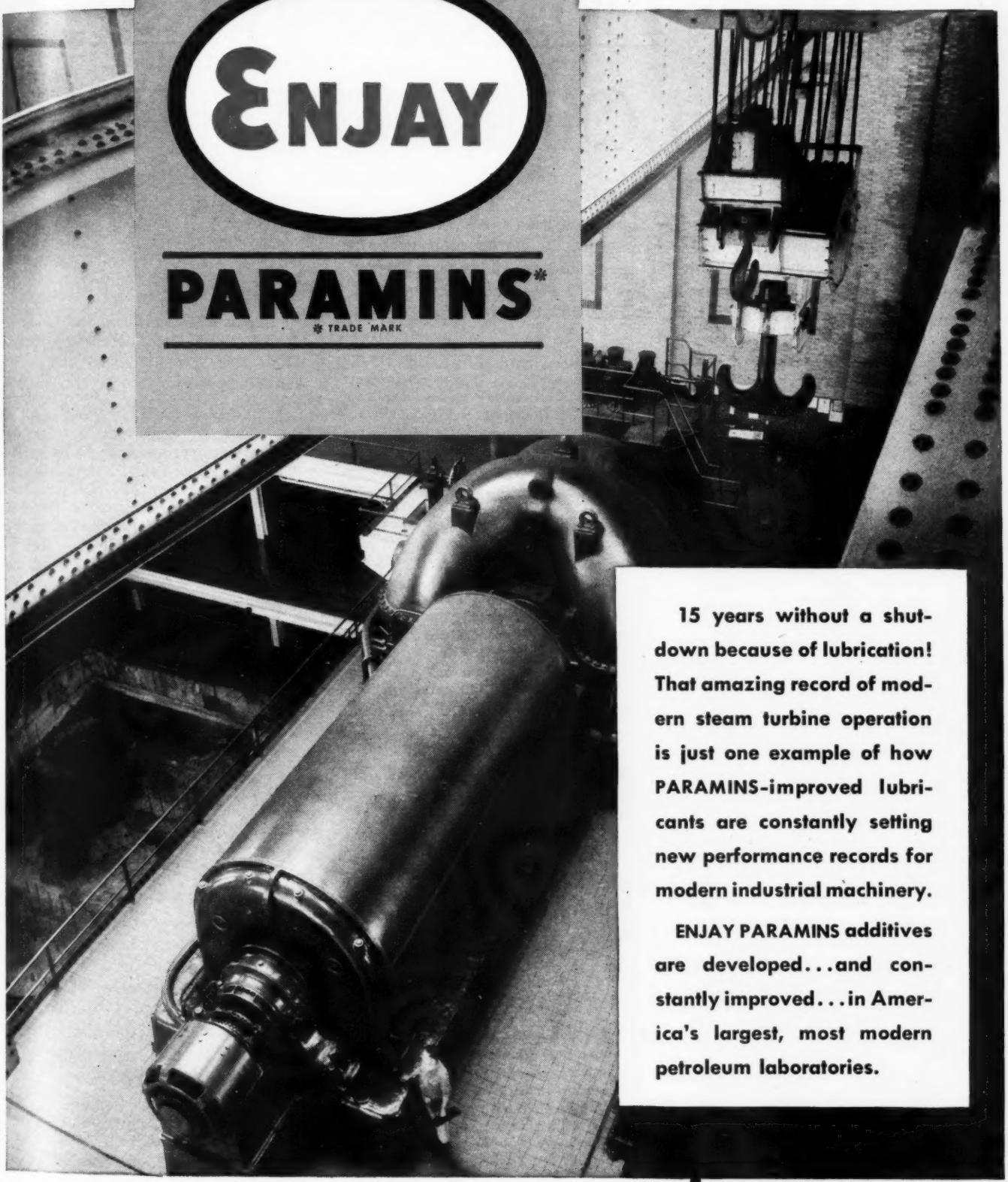


15 years without a shutdown because of lubrication! That amazing record of modern steam turbine operation is just one example of how PARAMINS-improved lubricants are constantly setting new performance records for modern industrial machinery.

ENJAY PARAMINS additives are developed...and constantly improved...in America's largest, most modern petroleum laboratories.

Proved PARAMINS mean improved oils and fuels

PARATONE—for improved viscosity index. **PARAFLOW**—for lower stable pour. **PARATAC**—for tacky oils and greases. **PARAPOID**—for E. P. gear oils. **PARANOX**—for oxidation inhibition and detergency. **PARASHEEN**—for better appearance. **PARADYNE**—for improved gasoline.

PARAMINS* * TRADE MARK

ENJAY COMPANY, INC.
15 West 51st Street
New York 19, New York

Standard Oil Company (New Jersey) Reports for 1948...

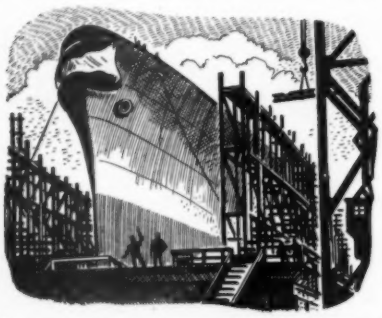
A year of Progress and Results for an Oil-using World!..

OIL SHORTAGE FEARS of a year ago have vanished. All around the world, oil resources are expanding. In doing their part to meet the rising needs for oil, this Company and its affiliates last year made the greatest efforts in their history. Here are some facts from this Company's Annual Report to its more than 200,000 stockholders . . .

1 TOTAL PRODUCTION AGAIN INCREASED. After setting new records in both 1946 and 1947, this Company and affiliates in 1948 increased crude oil production by 8% over the year before. Output of crude oil by our domestic affiliates represented 9% of the total crude produced in the U.S. Output of affiliates, world-wide, represented 14% of world production.

More wells drilled than ever before. Proved reserves increased

2 SEARCH FOR NEW OIL SOURCES SET RECORDS. More wells were drilled than ever before. Costs for this were a record $374,000,000 in 1948. Proved reserves in the earth at year's end were at a new high.



14 new Supertankers ordered, each nearly twice the size of wartime tankers

3 EVEN GREATER COSTS FOR EXPANSION AND REPLACEMENT were again required to meet rising needs for oil. Jersey Standard and affiliates spent a record $529,415,000 in 1948, even more than 1947's investment of 426 millions. For these needs and payment of dividends, money again was drawn from earnings, from borrowing, from sale of assets, and from further call on savings of past years.

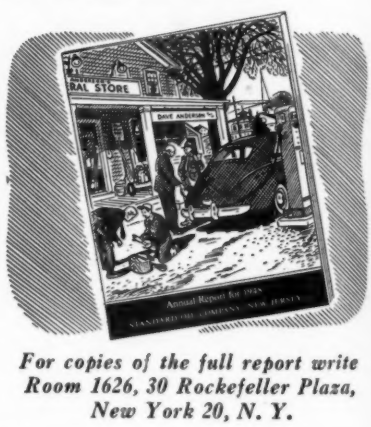
4 NEW FACILITIES RESULTED ALL OVER THE OIL-PRODUCING WORLD. In Venezuela, the world's largest pipeline was completed. Fourteen new supertankers were ordered, each nearly twice the capacity of wartime tankers. At Montreal and Edmonton in Canada; at Billings, Montana; Linden, New Jersey; and Baton Rouge, Louisiana, new refining facilities for more and better oil products went into service. At Amuay, Venezuela, a new 60,000 barrels per day refinery neared completion.

New facilities like this modern refinery help increase oil supplies

5 RELATIONS WITH EMPLOYEES CONTINUED EXCELLENT. Again there were no domestic strikes or work stoppages. At year's end the gross investment in property, plant and equipment amounted to $26,600 for each of the 129,000 employees of Jersey and its affiliated companies.

6 BOTH INCOME AND EXPENDITURES ROSE. As reported in the consolidated statement, total income of all companies was $3,332,187,000, an increase of 40% over 1947. At the same time, costs were also up 40%. $1,386,248,000 was paid for crude oil and other supplies, $573,459,000 paid to employees, $492,000,000 for other operating costs. Taxes of $268,000,000 were paid.

7 RECORD NET EARNINGS, LARGELY PLOUGHED BACK. Consolidated net earnings totaled $365,605,000. Yet this total, plus affiliates' earnings assignable to stockholders other than Jersey, plus all of the year's depreciation allowances was just about equal to the amount of money put back into the business to meet pressing needs for expansion and replacements. Stockholders of Standard Oil Company (N.J.) received dividends of $2.00 per share of the Company's stock, plus a stock dividend of two shares for each 40 shares held.



For copies of the full report write Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

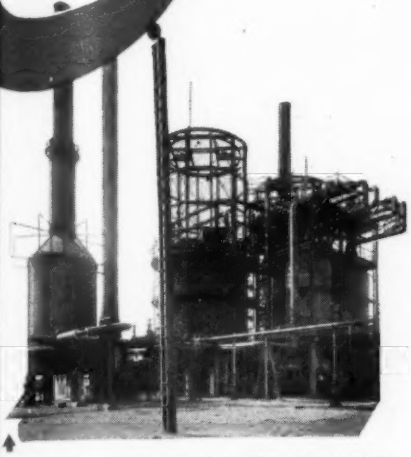
ALTHOUGH world oil consumption for the year increased 6.5%, and U.S. consumption 5.6% . . . the need was met and more. Threatened shortages were averted. Proved reserves in the earth are greater than ever before. New, modern facilities for meeting present and future needs are coming into operation throughout the world. Increasingly, human progress calls for more and more oil. In every way, the year 1948 was a year of progress and results for an oil-using world.

The better you live, the more oil you use!

STANDARD OIL COMPANY (NEW JERSEY)

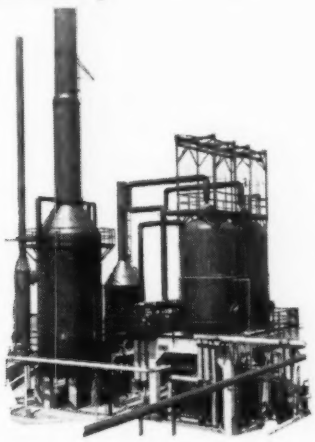
AND AFFILIATED COMPANIES

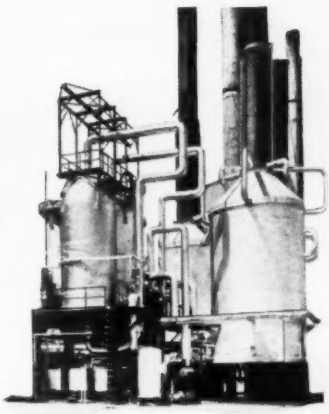
5 More PERCO® Units



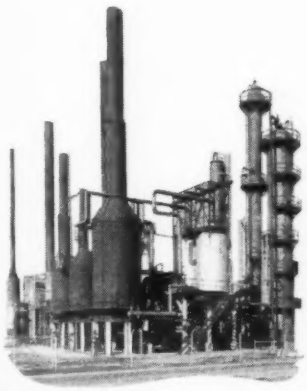
WOOD RIVER OIL & REFINING CO., INC., Hartford, Ill. — 10,000 B/D Straight Run and Cracked Gasoline Reforming and Gas Oil Cracking.

KANOTEX REFINING COMPANY, Arkansas City, Kansas — 4,200 B/D Straight Run and Cracked Gasoline Reforming.

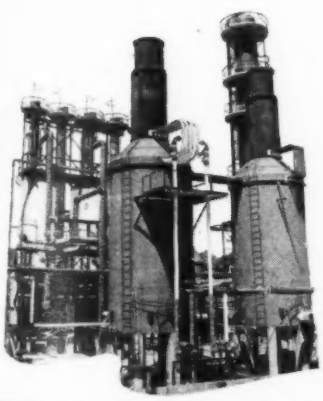




NATIONAL COOPERATIVE REFINERY ASSOCIATION, McPherson, Kansas — 5,000 B/D Straight Run and Cracked Gasoline Reforming.



BARECO OIL COMPANY, Wichita, Kansas — 4,000 B/D Straight Run and Cracked Gasoline Reforming.



ROOSEVELT OIL & REFINING CORP., Mt. Pleasant, Michigan — 3,000 B/D Straight Run Gasoline Desulfurization Reforming.

engineered by KOCH

5 more refiners are far ahead in the octane race because they chose Perco catalytic reforming units. With Perco units they can upgrade the leaded octane ratings of their gasolines by 6 to 8 numbers or more. Regardless of size, these Perco units cost less and are far more flexible than thermal reforming units. The economical design of a Perco unit requires years of "know how" — the kind of experience Koch has obtained by building many more Perco units than any other company. We will be glad to tell you how much a Perco unit will cost and what it will do for you . . . no obligation. *Write us, today.*

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THE KOCH ENGINEERING COMPANY, INC.

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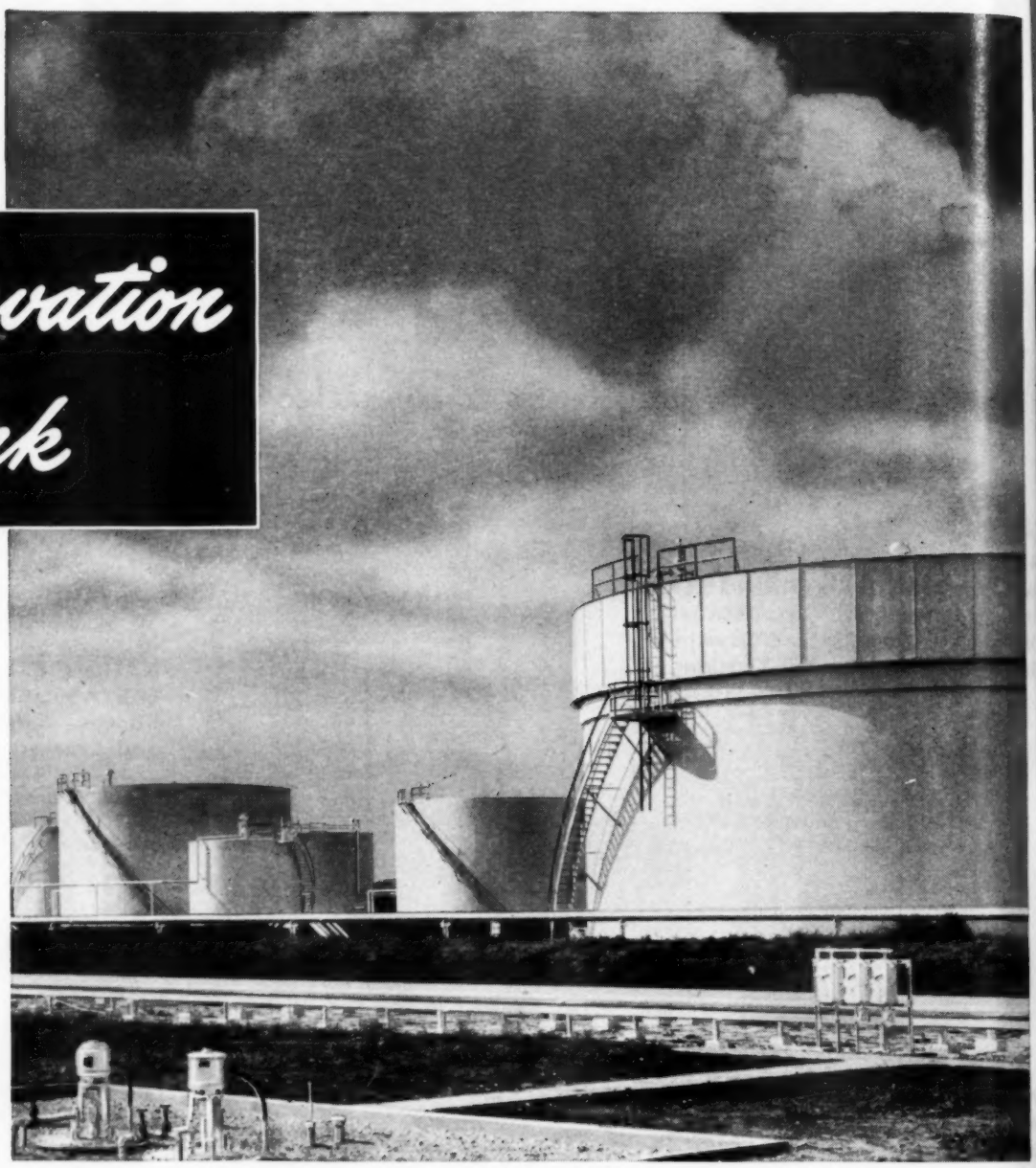
Conservation at work



THE EXPANSION ROOF STOPS PROFIT LEAKS

Narrowing margins demand optimum operating economy wherever petroleum products are stored. That's why producers, processors and marketers alike have turned to the Expansion Roof. Here's what it means to them:

ECONOMY . . . The end of evaporation losses
PAYOUT . . . Protection of multiple tank installations through manifolding
PRODUCT QUALITY . . . Maintenance of quality during the storage period
SAFETY . . Reduced fire hazard, Underwriters' approved
SIMPLICITY. . . No problem of maintenance
PERMANENCE . . No parts to wear, the Expansion Roof will last the life of the tank

In the face of narrowing margins, call on Graver today. Our engineers will analyze your storage problems without obligation and show you how the Expansion Roof can stop your profit leaks.

FABRICATED PLATE DIVISION

GRAVER

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

Making the Most of Oil & Steel

Maximum recovery of marketable products with steel and construction costs held to a minimum form the constant pattern of our work. This earnest effort we apply with equal vigor to complete building projects and smaller remodeling jobs. Our Engineering & Construction Division may be reached over L. D. 307, Tulsa, Oklahoma. It is suggested you include us in your early planning so that our broad experience may be applied to the fullest.

Engineering and Construction Division

JONES & LAUGHLIN SUPPLY COMPANY

TULSA, OKLAHOMA

Lightweight MONEL Bubble Trays and Caps

RESIST CORROSION
REDUCE COKING
CUT EXPLOSION DAMAGE

THIS LIGHTWEIGHT *corrosion-resistant Monel bubble tray has circular downcomer, individual snap-in cap holddowns, set-on type riser and individually bolted caps. Holddown frogs snap into riser openings, and can be installed or removed from top of deck.* PHOTO COURTESY OF THE FABRICATOR, FRITZ W. GLITSCH & SONS, DALLAS, TEXAS.

Corrosion eats equipment. And it ups costs all along the line, especially where sour crudes are refined.

You can cut corrosion's bite to *nibble size*—by using Monel* for bubble tray and cap assemblies in the top sections of primary crude towers.

In these sections where, at temperatures below 500° F., dilute hydrochloric acid plays havoc with most materials, Monel offers an ideal economical solution. Monel's resistance to corrosion attack promotes a lasting, smooth, coke-resisting surface. Its high strength and low corrosion rate make possible the use of thin, lightweight sections which save you money both in material costs and in tower design.

The Glitsch "Truss-Type" bubble tray illustrated above makes possible these advantages of wrought Monel construction . . .

Light weight—saves time and dollars in erection and maintenance.

Smooth surfaces—increases tower efficiency . . . lessens coking hazards.

Ductility — eliminates cap and tray breakage in cleaning and installation.

Safety—the light weight and ductility of Monel trays allow minor explosions and pressure surges within the tower to expend themselves without damage to the vessel. They greatly reduce the hazard to workers entering a vessel which has undergone an explosion. And Monel trays and caps, distorted by an explosion, may be easily straightened in the field and returned to service.

So before you choose any metal for cap and tray assemblies, consider the advantages of Monel. Write for information and technical data relating to Inco Nickel Alloys in refining equipment.

EMBLEM OF SERVICE

INCO

TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

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MONEL... *for minimum maintenance and replacement*

Complete Selection

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New Fluid Unit to Boost Capacity at Rock Island

By L. E. Kincannon
Vice President and General Manager
Rock Island Refining Corporation

When Rock Island's new fluid catalytic cracking unit goes on stream in July, we expect to increase our capacity to 10,000 b/d. The changes in processing equipment will result in improved gasoline and increase in middle distillates and a reduction in the yields of residual fuel oil.

L. E. Kincannon

Our refinery, near Indianapolis, Ind. now processes about 8,500 b/d, and while we have made maximum use of our existing equipment through efficient waste heat utilization, we anticipate considerable improvement in yield with the new unit. This is shown in the comparison of our present and projected yields shown below.

Comparison of Yields

	Percent Present (Thermal Cracking)	Percent Expected (Cat Cracking)
80 Octane Gasoline..	48.5*	50.0**
Stoddard Solvent	3.0	3.0
Kerosene	15.0	12.5
No. 3 Fuel.....	6.5	17.0
No. 5 Fuel.....		3.6
No. 6 Fuel.....	22.0	10.0
LPG		1.9
Total Recovery.....	95.0	98.0

*Requires 3 cc TEL
**Requires 1.75 cc TEL

The original plant, built in 1941, consisted of a crude oil heater and fractionator, a vacuum unit, a combination thermal cracker and reformer and necessary auxiliaries. Rated capacity was 5,000 b/d. Within six months after operations were begun, however, capacity was raised to 6,000 b/d with the use of heat exchangers.

In 1945, a catalytic polymerization unit was installed, producing 250 b/d of polymer, thus raising the octane of the gasoline output. In 1946, additional heaters further increased our capacity.

Having boosted our capacity to about 8,500 b/d, we felt we had reached the limits of our existing equipment. After a thorough study of the UOP Improved Fluid Catalytic Cracking Unit and comparisons with other available processes, we requested Universal Oil Products to design a unit for us. This unit, with a capacity of 5,000 b/d, is now under construction.

The New Unit

The new cat cracker, like others of the type designed by Universal, has been planned to use existing equipment as far as possible. For example, the fractionator on the thermal unit was large enough to handle the capacity of the cat cracker. It had sufficient trays to fractionate the gasoline, and space for addi-

(Advertisement)

tional trays to fractionate between the furnace oil and heavy cycle fuel oil. A small auxiliary column was needed to accommodate recirculating column bottoms to wash out catalyst fines and take out the small amount of slurry oil.

The present poly unit is large enough to handle the cracked gases, removing olefins from the gas as polymers. A new Universal-designed LPG unit will handle higher paraffins from the poly unit.

Operating Plan

Five thousand b/d of charging stock enters the cat cracker at about 500° F. and is joined by about 2,000 b/d of heavy recycle from the fractionating column and 250 b/d of slurry oil returning entrained catalyst to the reactor. This combined feed enters the bottom of the riser contacting hot catalyst descending from the regenerator, and is vaporized by the heat in this catalyst and carries the catalyst up into the bottom of the reactor. The oil vapor rises through the reactor and leaves by way of cyclone separators that remove practically all of the catalyst, then goes into the bottom of the auxiliary column.

A stream of oil is recirculated from the bottom of this column through a steam generator and back over the lower pans in the column. The stream washes down catalyst and condenses about 500 b/d of heavy slurry oil. This slurry is taken from the pump discharge to the settler where half of it is clarified and taken to storage. The rest, carrying catalyst, is recycled from the settler to join the combined feed.

Vapors from the auxiliary column pass to the bottom of the main fractionating column, the bottoms from which are pumped to four streams. The first is cooled and recycled over the lower pans of the fractionating column to control split between furnace and heavy fuel oil.

The second is pumped back over the top of the auxiliary column as reflux. The third forms the 2,000 barrels of recycle to the combined feed, and the fourth stream is stripped and goes to storage as heavy fuel oil.

Furnace oil from a center well in the fractionating column is circulated through another steam generator and returns to the column three decks above, for cooling and assisting in heat balancing the column. The furnace oil product flows from the center well through a stripper and is pumped to storage. A small naphtha stream is taken from the fourth deck, stripped, and used as a sponge medium in the top of the absorber. The distillate and gas pass overhead and are condensed.

Simplified Construction

As contrasted with earlier cat crackers, the function of the fractionating tower has been split between two vessels, removal of catalyst carry over and residual fuel oil being done in an auxiliary column. In order to save space and vessel construction, this auxiliary column and the slurry settler, although functionally distinct, were constructed as one unit and separated into two compartments by a head.

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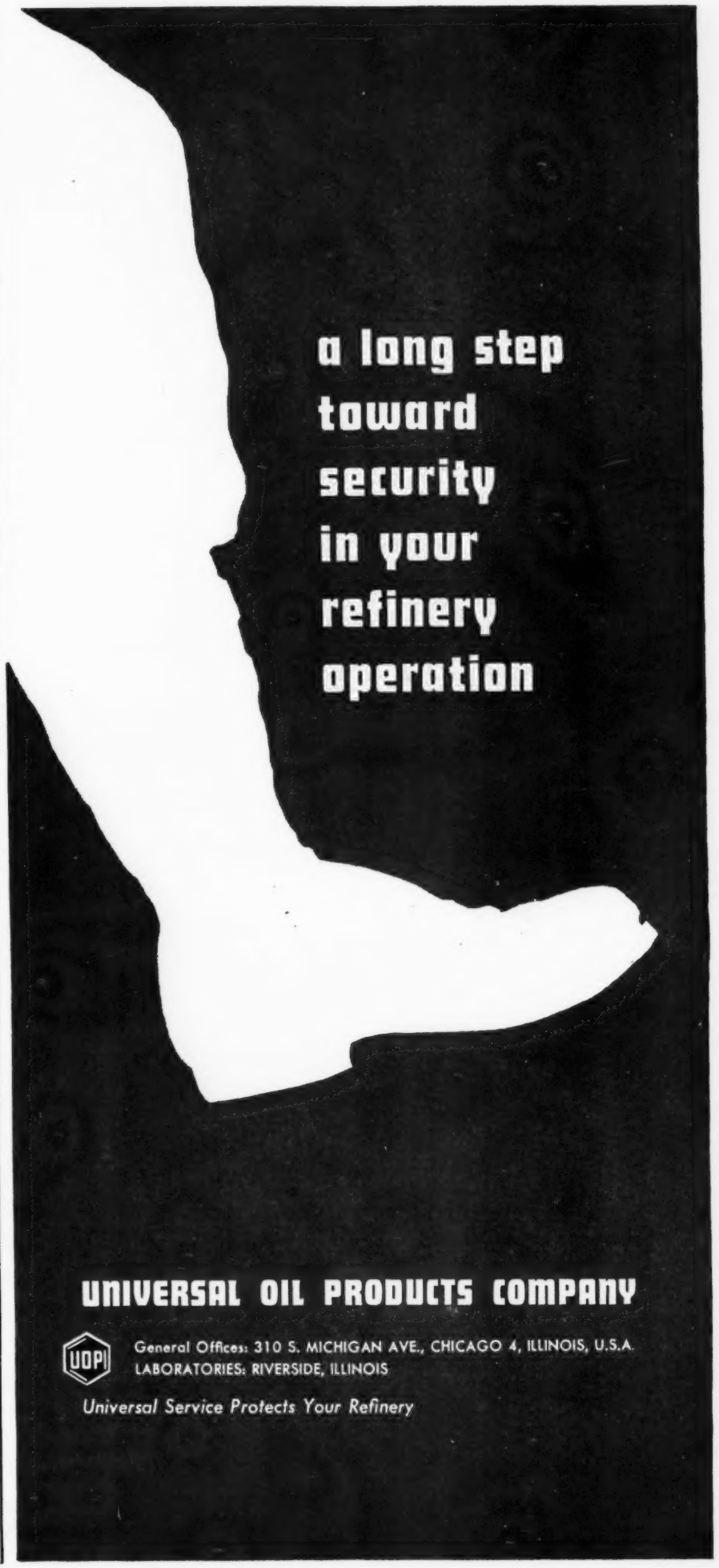

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Oil A-Plenty—But Bureaucrats Press For a Synthetic Fuel Industry

By WILLIAM F. BLAND
Engineering Editor

WASHINGTON — Establishment of a synthetic liquid fuels industry on a government-subsidized basis, without regard to need or cost, and in direct competition with existing petroleum refineries, still appears to be the aim of the Federal Department of the Interior and its Bureau of Mines.

Despite all indications that there is presently no need for commercial plants to produce liquid fuels from coal or oil shale, the Interior and Bureau staffs continue to press for their program.

They have prompted legislation now in Congress which would authorize the Reconstruction Finance Corp. to make loans to private interests for the construction and operation of such commercial plants. At the same time the legislation would give the Interior Dept. virtually life and death control over the proposed plants, by specifying that "the Secretary of the Interior shall determine the basic economic and technologic considerations . . . including the area of location, raw materials, basic processes, and capacity of any synthetic liquid fuel plant which may be involved."

McCarran, Wolverton Author Bills

The bill, S. 6, was introduced Jan. 5 by Senator McCarran of Nevada and then amended May 2; it is now before the Senate Committee on Interstate and Foreign Commerce. A bill similar to the original S. 6 is before the House of Representatives, H.R. 566, introduced Jan. 3 by Rep. Wolverton of New Jersey.

The amended McCarran bill contains provisions which would appear to be an attempt to put the government in the oil business. The bill states that if "the Secretary of the Interior determines that, to effectuate the purposes of this Act and to supplement any action that may have been taken by private industry . . . the Government should itself construct and operate a commercial synthetic liquid fuel plant or plants, he shall so certify to the Reconstruction Finance Corp., with a specification of the design capacity, the area of location, the raw materials, the basic processes, and the capacity of each plant or plants.

"The Reconstruction Finance Corp. shall thereupon negotiate contracts with qualified private persons for the construction and operation of the plant or plants specified by the Secretary of the Interior, subject to the approval of the Secretary of the Interior with respect to basic economic and technologic considerations, including the matters previously specified by him."

To enable the proposed plants to operate in competition with existing refineries, the McCarran legislation gives the Interior Secretary what in effect amounts to the power to fix prices for the petroleum products. One section of the bill states that he "may at any time determine and certify to the Reconstruction Finance Corp. that the purchase of the products of synthetic liquid fuel plants in general or of any plant or plants in particular, at prices in excess of those obtainable in the open market, would be appropriate for the purposes of this Act; and the Reconstruction Finance Corp. shall thereupon negotiate for the purchase of such products upon such terms as the Secretary of the Interior may approve; and the Reconstruction Finance Corp. shall thereafter sell such products in the open market upon the best terms available."

On what grounds is the Interior Dept. and the Bureau attempting to force synthetic fuels upon the country? What excuses are they using?

Six years ago, in 1943, when the Bureau first began promoting its present program, it was talking about research and development to aid private industry. At that time, Senator O'Mahoney of Wyoming, who authored the original bill which set up the Bureau's present research program, stated on the floor of the Senate during debate on the measure, "the purpose is merely to conduct experiments" and "not to invade the field of commercial production at all."

"Experiment" Costing $60,000,000

The Bureau's "experiment" has now reached the proportions of a 200 b/d semi-commercial demonstration plant (at Louisiana, Mo.) and is costing the U. S. taxpayers $60,000,000 plus whatever additional amounts the Bureau is sure to request to keep the program going.

During the past few years, taking advantage of a temporary unbalance of supply and demand caused for the most part by transportation and equipment shortages, the Bureau has been advocating the erection of commercial plants on the grounds that the end of our present supplies of petroleum was, according to their calculations, almost in sight.

Then in January of 1948, the late James Forrestal, at that time Secretary of Defense, added fuel to the Bureau's program by stating flatly that U. S. military and civilian petroleum needs in the event of a major war effort would exceed by at

least 2 million b/d the foreseeable production of the U. S.

Without even considering that Forrestal's 2 million b/d figure perhaps wasn't just exactly correct, the Secretary of the Interior jumped into the opening. He recommended to Congress that a program to establish a synthetic fuel industry capable of overcoming that mythical 2 million b/d shortage "be undertaken now when the country is at peace and completed over a period of 5 to 10 years."

Military Reverses Thinking

More recently the military has changed its thinking. A few months ago, in fact, it completely reversed its position with respect to the previously-predicted 2 million b/d shortage, and admitted that the liquid fuel requirements of a major war effort on the part of the U. S. could be supplied entirely from natural petroleum.

The earlier estimates, it now develops, were based on several drastic assumptions, including (1) that no oil would be available from outside the U. S., and (2) that the military demand would immediately reach full-scale proportions. It would also appear that sharp civilian rationing was not contemplated.

Present military thinking was expressed in a statement made last March by Under Secretary W. John Kenney, speaking for the National Military Establishment. "Current upward revisions of estimated potential availabilities through technical progress and new discoveries," he said, "indicate an improved wartime petroleum supply situation over that to which Mr. Forrestal referred last year. His statement at that time was based upon the assumption, made by his military advisors, that requirements would have to be met entirely from production within the Continental U. S.

"This assumption presented such a dire picture that the entire matter was thoroughly reviewed. This review now indicates that we can be justified in assuming that a certain supply of oil will be available in the event of hostilities, from sources in this Hemisphere, outside the Continental U. S. However, even with this improvement, current estimates indicate that in the event of war severe rationing will be necessary to meet requirements."

Change to Long-Term View

With the props thus knocked out from under its argument for the immediate construction of a full-scale synthetic fuel industry to meet military needs, the Interior Department is now concentrating on the long-term need. Today it is talking about how hard-pressed we're going to be for oil along about 1975—instead of in just five or so years, as formerly.

That change in thinking from the near-future to the long-term picture was the main point to be noted in a paper presented last month by Dr. W. C. Schroeder, chief of the Bureau's synthetic fuels work, at the annual meeting of the Oil Heat Institute in Boston.

By 1975, according to a series of charts accompanying Schroeder's paper, domestic oil will be able to supply only about 20 to 25% of the total U. S. demand for petroleum products. Schroeder estimated that annual domestic production by then will have dropped to about 1.2 billion bbls., and that annual domestic demand at the same time will have risen to somewhere between 4.7 and 6.0 billion bbls.

With the present petroleum supply situation as it is and even the military in agreement with the industry as to the foreseeable future, one would think that the Bureau would content itself with its original program of research—and forego the honor of developing a new industry until the need for such an industry exists.

But that is not the way of things. The Bureau's contention now is that we must build plants of 10,000 b/d capacity to develop the techniques and acquire the technical know-how so that we'll be able to build and operate the commercial plants whenever we might need them.

Industry Doesn't Agree

"Completely screwy" is the way one industry executive expressed himself to us when asked what he thought of that idea.

The rapidity with which improvements in synthesis processes are now being developed, he went on to explain, would make any plant built today obsolete by the time it was ready to go on stream. In addition, with a plant that large you're up against a time problem when you want to do some experimenting. It just takes too long to shut it down, make equipment changes, and get it going again—aside from the expense in fabricating full-size experimental parts.

A 100 b/d demonstration plant, or even a smaller one, this same executive believes, is large enough for the purpose of developing techniques—and at the same time small enough to be flexible. "You can experiment with a plant of that size without spending weeks rebuilding it."

Eugene Ayres, director of the chemistry division of Gulf Research & Development Co., offers another viewpoint on "the freezing of technology in plants of commercial size." He says:

"It is rather interesting to consider what would have happened if commercial plants had been designed two years ago to produce 2 million b/d of liquid fuel from coal. These plants would not yet be ready to operate, but when completed they would require at least 70 million tons of coal per annum *more* than plants designed today.

"This extraordinarily rapid approach to obsolescence has come about through the active research effort of the Bureau of Mines and industrial laboratories. The annual saving of present design over that of two years ago is almost equal to the total amount of coal now used in this country for the generation of electric power.

"Some of the present ideas of technology are undoubtedly primitive compared with the technology that will be available a few years hence."

Advised to Delay Plans

Bearing out industry's attitude that plant's built today will be obsolete before they get into production is the report that a leading U. S. oil company has advised the Union of South Africa against proceeding with its current plans to erect a liquid fuels-from-coal plant near Johannesburg.

The U. S. firm, which has been among the leaders in the synthetic fuel field, was retained last year by South African officials in a consulting capacity. Its recent report, according to one source, recommended that the Union hold up its plans for a few years. It might appear economic at this time, the report explained, to build an oil-from-coal plant rather than laying out dollars to import natural petroleum products. Within a few years, however, the synthesis processes will probably have been so improved that the Union wouldn't be able economically to continue operating its 1949-model plant but would find it cheaper to build a new one. The net result, of course, would be that the Union would be out more dollars in the end.

National Oil Policy

The attitude of the oil industry in general towards government intervention in the synthetic field is best expressed by the National Petroleum Council in its recent recommendations for a national oil policy. In speaking of the force of technology in expanding our petroleum reserves, the Council states:

"The oil industry through extensive research has provided the technological basis on which a synthetic fuels industry can be established when conditions require. . . . The construction of synthetic fuel plants by government intervention would defeat the objectives of an adequate oil supply by impeding the normal development of the industry.

"Synthetic fuels will attain an orderly and economic development by private industry, if normal incentives are free to operate."

Oil's Enterprise, Freed from Controls, In 1948 Ended "Shortage" Bugaboo

WHAT HAPPENED to the petroleum supply to convince the military, the oil industry authorities and in fact about everyone that there is no likelihood of a petroleum shortage in this country in the foreseeable future? Everyone, that is, except the government bureaucrats who still want to establish a subsidized synthetic fuel industry in the U. S.

In 1948 the results of the efforts the oil industry had launched at the end of the war to increase petroleum supplies became apparent. The oil companies' drive gathered impetus as the various wartime controls ended and material shortages disappeared. Taking 1948 as a starting point, one oil company has made the following judgment as to how production could be expanded in the Western Hemisphere in coming years, if required:

1—Net shipments out of the Western Hemisphere in 1948 were 523,000 b/d, excluding U. S. military shipments to Eastern Hemisphere destinations and ships' bunkers loaded in the Western Hemisphere but consumed in the Eastern Hemisphere. Therefore, it is safe to say there was a net physical movement of oil from the Western Hemisphere to the Eastern Hemisphere of more than 560,000 b/d in 1948.

2—In 1948 stocks increased 240,000 b/d in the Western Hemisphere.

Excess Tops Million b/d

3—Adding these items, it is apparent that production exceeded consumption during 1948 in the Western Hemisphere by 800,000 b/d. Furthermore, the rate of production at the end of the year was 300,000 b/d higher than the average for the year. In other words, actual productive capacity at the end of 1948 was 1,100,000 b/d above average consumption for the year.

4—Productive capacity in the Western Hemisphere increased during 1948 at the rate of nearly 600,000 b/d, or more than 8% of the consumption in the Western Hemisphere. There is no evidence that this rate of increase could not be continued for some years, if required. However, based on past trends it is unlikely that consumption will increase at that rate. So even a lower rate of increase in productive capacity than was proved to be possible should be sufficient to keep up with increasing consumption. In addition, there is the 1,100,000 b/d of productive capacity above average consumption in the Western Hemisphere as a backlog.

5—In addition to this favorable outlook, there are at least 500,000 b/d of residual fuel produced at U. S. refineries at present which could be converted into gasoline and other products if the equipment is installed to do so. Under present economic conditions there appears to be an attractive return of investment for installing such facilities, so it is reasonable to expect this will continue to take place.

Natural Petroleum Adequate

There is no evidence as yet that natural petroleum cannot be made available in adequate amounts to meet all needs in the foreseeable future, the oil company's statement concludes. Some day the trends and indications may change, and the evidence may point to the need for synthetic fuel production in five or ten years hence. Then will be the time for the oil industry to plan to build the plants to make synthetic fuels from whatever raw materials appear most practical at that time.

The abrupt change in viewpoint of the nation's military authorities as to the possibility of a shortage of petroleum supplies in the foreseeable future may have been brought about in part at least by an address which Bruce K. Brown, vice president, Standard Oil Co. (Indiana), made before two of the Armed Services War Colleges early in 1949. Mr. Brown is chairman of the Military Petroleum Advisory Board appointed by the Secretary of the Interior at the request of the National Military Establishment.

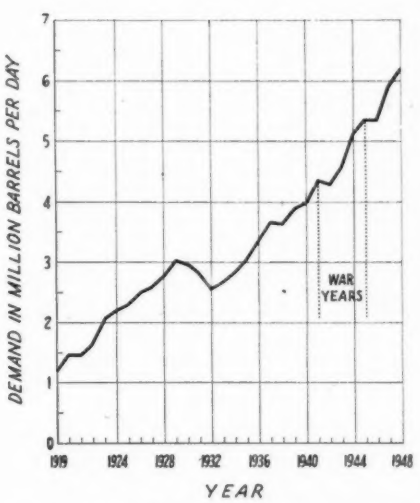


Fig. 1—Total U. S. demand for all petroleum products (domestic, export, and military) in war and in peace years

"I think we could fight and win a war on the basis of the petroleum we would find available if war comes again," Mr. Brown stated. He said he disagreed entirely with statements made towards the close of World War II that we could never fuel another war, or that we would be "short" two million barrels a day of the petroleum necessary to fuel a war. None of the figures we now have on hand indicates that, he said.

"Because there were 'spot shortages' in fuel oil supply in the winter of 1947, a school of thought grew up in Washington to the effect that some sort of 'controls' ought to be exercised over petroleum as a 'scarce material'," he stated. "However, before the professors and the legislative counsels could get a good start on their bills for the 81st Congress, the supply situation changed from one of scarcity to one of surplus.

"Instead of crude shortages and product shortages, we have state governmental restrictions on crude production and industry restrictions of crude runs.

War No Drain on Reserves

Mr. Brown refuted the talk about the exhaustion of our petroleum reserves due to the drains of war by introducing a chart, Fig. 1, showing the trend of total U. S. demand for all petroleum products from 1919 to date. "Note that the rate of increase during the war years actually was not much different than during the prewar or postwar years," he said.

"As a matter of fact, a most expert economist or statistician who had been kept in ignorance of world affairs to the extent that he did not know of World War II could not conclude from this consumption chart that any such upheaval had taken place. The demand for petroleum products tends to go up whether we are at peace or at war. This increase reflects mainly, I believe, the number of people, the number of machines used in our civilization, and our relative prosperity, rather than any difference between peace or war."

—V.B.G.

FLOCCULATION—

A Method for Conditioning Refinery Effluent for Re-Use, Disposal

By F. M. FAULCONER, D. L. McCANN and H. L. BEDELL

Socony-Vacuum Oil Co., White Eagle Division, Augusta, Kans.

A description is presented of a method of partial conditioning of petroleum refinery effluent for re-use and disposal as applied in the operation of a 26,500 b/d skimming and cracking plant. The method involves a process of collection, cold process-water treating, and filtering to soften the water, to remove oil and solids, and for the return of the water to the plant cooling system.

In the recirculation of the water within the plant, a higher concentration of dissolved solids is permitted so that the total effluent which must be eliminated from the plant is reduced to a minimum. This effluent is finally treated to remove all evidence of oil and most of the other contaminants. The water has little odor and generally a good appearance, and contributes no deleterious effects to the local surface drainage streams.

This article was originally presented as a paper before a group session on the disposal of refinery wastes during the meeting of the API Division of Refining in Houston, April 4-7, 1949. As published here the paper is essentially complete, with the exception of an introductory section which included a discussion of waste water problems.

AS IN MANY INDUSTRIES, water is a major chemical in the refining of petroleum oils. Its physical and chemical characteristics make it an essential agent in almost all phases of refinery operations. It is readily available in copious quantities, in general, and it may be used to an almost unlimited extent except for the problem of disposal which accompanies its use.

As a partial approach to the solution of this disposal problem, we are describing here a system of water handling and treatment in use in our plant—a system which has resulted in a vast improvement in the condition of the water at the point of final disposal. Although this operation is not perfect, and is open to criticism in certain instances, it may offer some suggestions to operating personnel in other plants who are responsible for action in this direction.

Our refinery is an inland skimming and cracking plant, with approximately 26,500 b/d crude charging capacity. Its process facilities include Houdry catalytic cracking and HF alkylation. The source of coolant water is a relatively small Kansas river. During periods of extremely dry weather total flow in the stream may get as low as 1000 gpm, and at such times the water removed from the river for refinery use may be a relatively large proportion of the total flow. The water for power-plant and processing use is obtained from an impounded reservoir. A large portion of this water finally is sent to the surface stream.

The concentration of solids in the water system depends upon the amount of blowdown which is permitted. The total system contains about 1,500,000 gal. of water. The average flow of effluent from the entire water system has been at an average rate of 1500 gpm.

Equipment and Operations

Preliminary studies and laboratory investigation indicate that the chemical costs for conditioning 1500 gpm of effluent water would be large; that, at the same time, the makeup water to the cooling towers would still be raw and scale-forming, and that it would contain large amounts of debris and silt during high water.

In determining the treatment necessary for conditioning 1500 gpm of water for disposal, this water was found to be suitable for use as cooling-tower makeup. This fact led to the design of a system which charges this effluent water back through a water-treating system so that it can be used as a cooling-water makeup. Thus the chemical treating should not only reduce the quantity of effluent, but it should also improve the refinery cooling water at substantially the same level of treating costs.

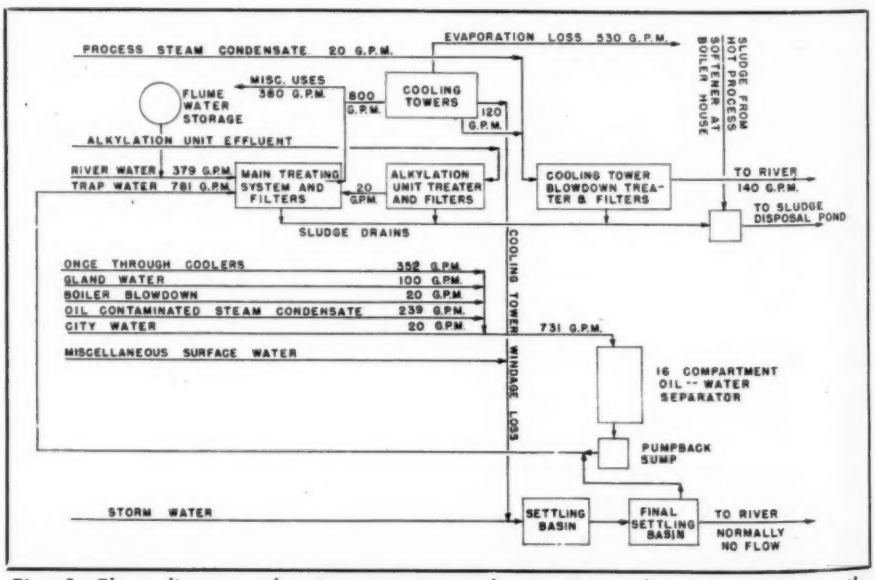


Fig. 1—Flow diagram showing sources and quantities of water going to the treating systems

The waste-water treating facilities which were finally designed consist of three separate systems. All separator water and water from the settling basin is blocked from the river and returned to be treated. This water, and additional river water if necessary, is clarified and softened in the first system for cooling-water makeup. Inasmuch as the cooling-water makeup is treated, only a small purge is necessary, for the reason that higher concentrations of solids are permitted with softened water.

This blowdown from the cooling towers is clarified in the second treating system, and it is discharged to the river as the only effluent water leaving the refinery.

A small, third treating system is operated to neutralize acids and to remove fluorides from the alkylation-unit waste and flushing water. Table 1 lists these three treating systems.

TABLE 1—Details on Treating Systems

System:	Main	Cooling-tower blowdown	Alkylation-unit effluent
Maximum rate (gpm):	1200	140	20
Water source:	Trap and river water	Cooling-tower blowdown	Alkylation-unit lime pit
Purpose:	Softening	Clarification and sulfide removal	Neutralization and fluoride removal
Chemicals used:	Lime Soda ash Ferric sulfate	Ferric sulfate Aluminum sulfate	Lime Ferric sulfate
Treater size (diameter of reactivator):	45 ft., 0 in.	13 ft., 6 in.	7 ft., 4 in.
Filters containing anthracite (number and diameter):	Six, 10-ft., 0-in.	Two, 5-ft., 6-in.	Two, 3-ft., 6-in.
Disposal of water:	To treated-water storage tank; to cooling towers as makeup	To river	To main treating system

Main Treating System

The total cooling-tower treated makeup water, as well as water for other miscellaneous services such as once-through coolers, flushing water, and gland water, is clarified and softened in this system. This treating system was designed to provide makeup water for the following services:

	Gpm
1. Cooling-tower evaporation loss	530
2. Cooling-tower blowdown	120
3. Pump-gland water	100
4. Cooling-tower windage loss	50
5. Miscellaneous uses	380
Total	1,180

The quantities of raw water to be treated vary, but the following average quantities were used for design purposes:

	Gpm
1. Trap and settling-basin water:	
Pump-gland water	100
Cooling-tower windage loss	50
Once-through coolers	352
Process steam condensate	239
Boiler blowdown	20
Waste city water	20
Total	781
2. Treated alkylation-unit effluent	20
3. Raw river water	379
Total charge to treater	1,180

A flow diagram of the sources and quantities of water for this treating system, as well as for the other two systems, is shown in Fig. 1. A flow diagram of the treating facilities is shown in Fig. 2.

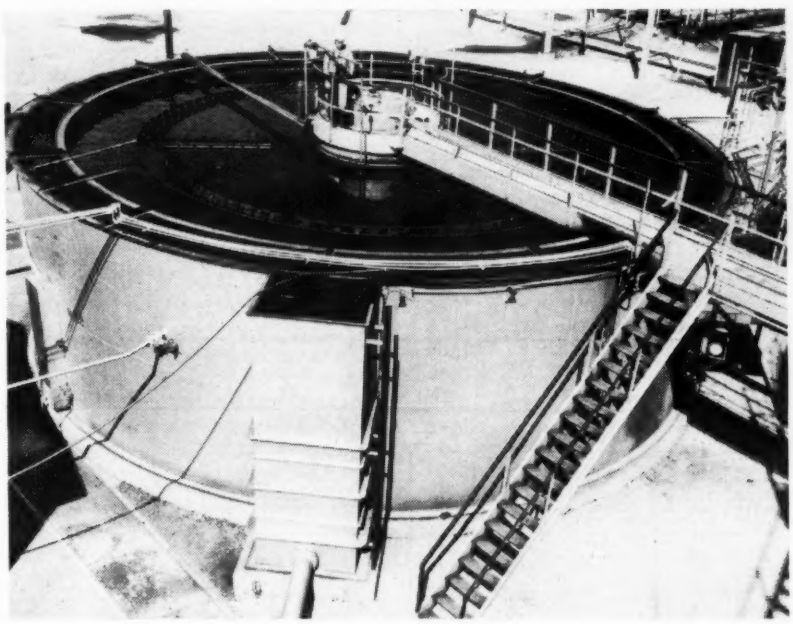
In connection with the water-treater installation, certain storm-water drainage areas have been diverted from the sewer and separator system. This storm water drains through a network of ditches, along with the cooling-water windage losses, to the settling basin. As much as 380 gpm of this storm water can be pumped back, replacing the raw river water to the settling tank. Larger amounts of surface water are collected in the basin so that they may be pumped back to the settling tank later or so that they will overflow into the river, depending on the amount of runoff.

The separator water and river water are pumped into a 20,000-bbl. open-top tank which allows a 12-hr. residence time to aid in separating silt and oil from the water. A skimmer is provided to float off the separated oil to the sewer, and two mud draws are provided to draw accumulated mud to the sludge sump. The water flows by gravity to the main treating reactivator, through a swing line which can be raised or lowered to draw water from the most clarified zone. The raw-water inlet line to the reactivator contains an orifice meter and a float-operated control valve for measuring and controlling the incoming water.

Each of the three treating systems includes a cold-process and sludge-recirculation type of treating unit called a reactivator, which was designed and built by Graver Tank and Manufacturing Co. These reactivators are standard Graver design, contained in a suitably sized open-top steel tank built completely above-ground. A sketch of a typical reactivator is shown in Fig. 3.

The raw water to be treated enters through the inlet line to the central mixing zone "A", where it mixes with internally recirculated water, sludge, and the necessary coagulant and treating chemicals. Air is introduced near the bottom of this mixing zone, and this causes a rising current of air and water up and out through the radial circulating pipes "B", into the outer coagulating zone "C". The water having been thoroughly mixed with sludge and chemicals is given a downward spiral motion in this annular coagulating zone, thus promoting the formation of floc particles. At the bottom of the coagulating zone the water is forced to flow across the bottom of the reactivator because of the circulation set up by the air lift in the mixing zone. An amount of water equal to the raw water introduced rises to the top of

This Month's Cover Picture



Close-up view of the cold-process and sludge-recirculation type of treating unit, called a reactivator, installed in the water treating plant at Socony-Vacuum's Augusta, Kans., refinery. This plant employs flocculation as the principal method of treatment, and produces an effluent which is suitable for re-use in the refinery. The refinery is the first one in the U. S., as far as the editors of Petroleum Processing have been able to determine, using the flocculation-type of water treatment unit

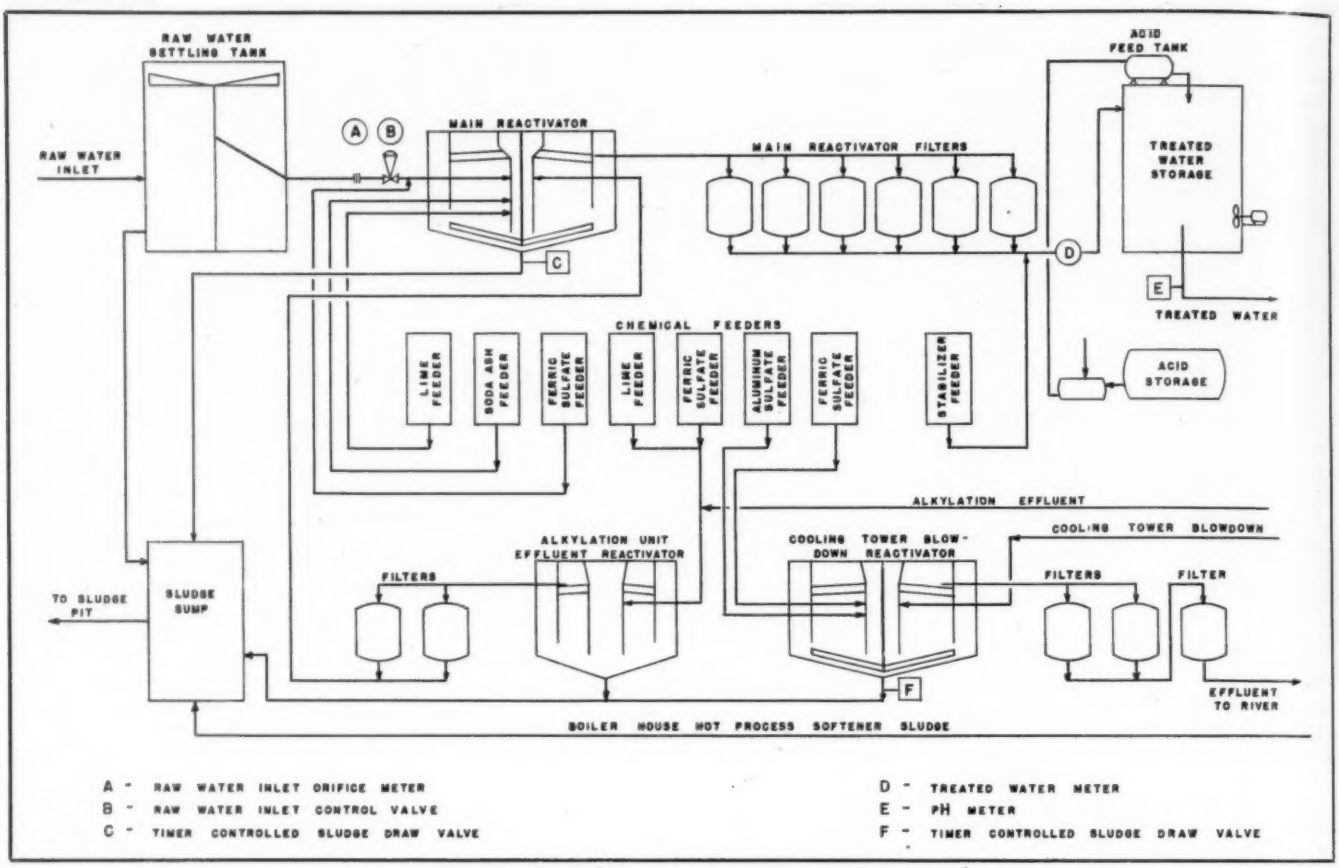


Fig. 2—Flow diagram of treating facilities

the clarification zone "D"; this water overflows the weir boxes "E" into the clear well "F". A sludge level is maintained by drawing the sludge through the bottom line for disposal. A motor-driven scraper "G" on the cone-shaped bottom moves the heavy sludge to the center sludge draw.

The raw water is clarified and softened in the reactivator—using lime, soda ash, and a coagulant, viz., ferric sulfate or aluminum sulfate. All chemicals are proportioned from individual Omega dry feeders controlled by automatic timers. The dry chemicals are put into solution or into a slurry with a minimum amount of water and recirculated sludge, and are pumped into the mixing zone of the reactivator. Sludge is drawn off through a timer-controlled solenoid valve to control the sludge level in the reactivator.

The treated water from the clear well is pumped through six 10-ft., 0-in. diameter filters containing anthracite. These filters operate from common inlet and outlet headers in parallel, so that each filter clarifies 200 gpm of water. The filters are back-washed once each day with treated water to remove the accumulated floc on the anthracite. A stabilizing phosphate is added, from an automatically controlled solution feeder, to the filtered water going to the treated-water tank.

A 5000-bbl. open-top tank is used as surge capacity for the treated water. The tank is provided with a mixer, and sulfuric acid is added to the water to maintain a controlled pH. A pH meter records the pH of a bleed stream of water from the suction line.

Treating Cooling-Tower Blowdown

The blowdown treating system was designed to neutralize and clarify the cooling-tower blowdown water, which is the only refinery effluent water flowing regularly to the river. The cooling-tower blowdown is manually controlled at a fixed rate to control the concentration of solids in the cooling-tower circulation system. This water flows directly into the reactivator, which has a diameter of 13 ft., 6 in. Aluminum sulfate and ferric sulfate are proportioned from Omega dry feeders, and are added with chemical pumps to the reaction zone of the reactivator. Lime is added occasionally as an aid to coagulation and pH adjustment. The sludge level is maintained in this reactivator with a timer controlled-sludge draw valve. The sludge drains to the sludge sump.

The clarified water overflows into a clear well, and is pumped through two 5 ft., 6-in. diameter anthracite-filled filters. The clear water is then discharged directly to the river. Provision is made to back-wash these

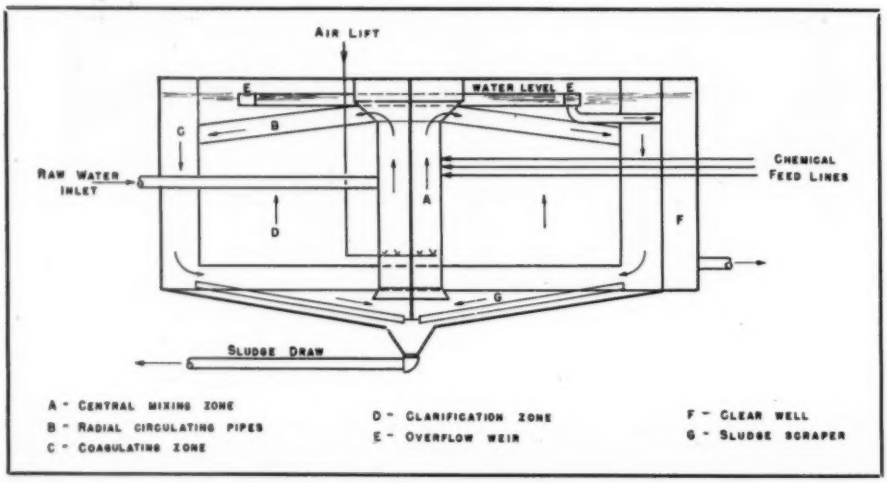
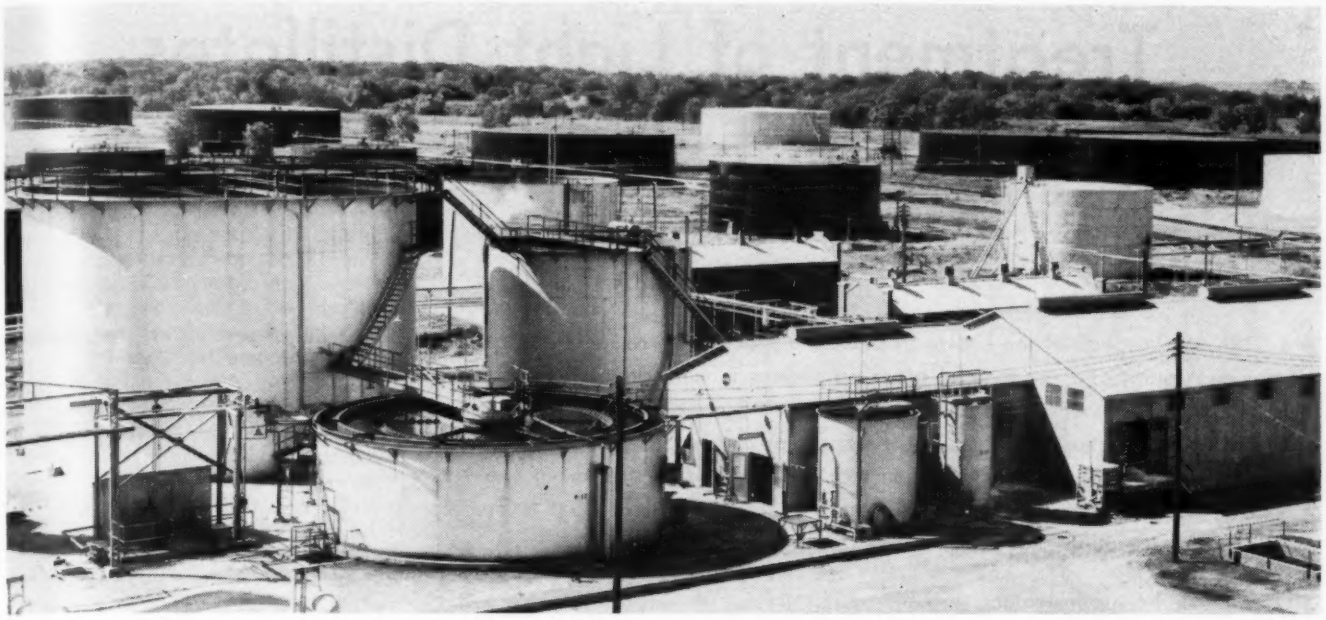


Fig. 3—Sketch of typical reactivator



General view of the water treating plant at Socony-Vacuum's Augusta, Kans., refinery

filters, and this is done once each day.

Treating Alkylation Unit Effluent

The alkylation-unit flush-water and acid drain from the acid area to a lime pit for neutralization. This 20 gpm of water, containing neutralized hydrofluoric acid and excess lime, is pumped to the water-treating area into the solution box of an Omega dry-lime feeder. The feeder adds lime to make a saturated lime solution, and a solution feeder adds ferric sulfate as a coagulant. This water, containing chemicals, is pumped into the 7-ft., 4-in. diameter reactivator, where the fluorides precipitate out of the saturated lime solution and are drawn off as sludge. The sludge level is controlled by a manually operated drawoff to the sludge sump. The clarified water overflows to a clear well, and is pumped through two 3-ft., 6-in. diameter filters, which clarify and remove the last traces of floc and sludge from the water. The filtered water discharges directly into the main reactivator—where, as saturated lime water, it supplies a portion of the necessary lime feed to that treater.

Operating Results

The treated-water makeup, softened and clarified in the main treating system, has been satisfactory. Very little turbidity has been noticed, and the water is light amber in color because of dissolved organic material. Due to the wide variance of the river water, typical analysis of all waters would be difficult to tabulate. Table 2 gives analyses of the river water, the raw water from the settling tank, the treated water, and the net effluent.

Total hardness of the effluent from the main treater has varied from 68 ppm, to 350 ppm, depending upon the hardness of river water. Partial softening, with emphasis on complete clarification and oil removal, has been practiced. The average chemical-treating costs have been $0.043 per thousand gallons of water charged to the treater.

The cleanliness of all towers, with regard to bacteria and algae growth, are improved a great deal. These organisms, which were for the most part introduced into the circulating systems with raw river water, are now apparently removed in the coagulation and filtering process. No chlorine or other algaecides have been used for the past year.

In Table 2, under net effluent, it will be noted that there are 313 ppm of ammonia ion. This ion is introduced into effluent by 20 gpm of process steam condensate from the combination topping and catalytic cracking units. The ammonia is added to prevent corrosion and thiosulfate is formed in the catalytic cracking process. As a result, about 1000 lb. per day of ammonium thiosulfate are formed. The sulfur is removed with ferric sulfate, and the iron sulfide precipitated is coagulated with aluminum sulfate. The ammonia ion remains, and is toxic to gold fish in concentrations of 100 ppm. It is necessary to have a dilution of some three parts of river water to one of effluent, so that the water is not harmful to aquatic life. This is no problem, as the effluent quantity of 100 gpm is diluted many times by the normal river flow.

The effluent water is clear and free of oil and phenol, but is amber in color because of the dissolved organic material. The oxygen demand of the river is affected only temporarily.

The alkylation-unit effluent treater has been operating satisfactorily. The fluoride content of the treated water is 1 ppm to 2 ppm. The idea of the original design was automatically to control the lime and ferric-sulfate feeders with timers. Because of the large fluctuation of water flow and pH of this water from the lime pit to this treater, it has been found more convenient with these feeders to control manually the addition of chemicals.

All three treating systems are centralized in one area so that the equipment can be conveniently operated with one operator per shift.

TABLE 2—Analyses of Typical Waters*

	River Water	Raw Water from Settling Tank	Treated Water	Net Effluent
Dissolved solids	2,810	3,340	3,490	11,300
Total hardness	500	357	128	512
Calcium hardness	410	280	69	320
Magnesium hardness	90	77	59	192
Phenolphthalein alkalinity	0	68	85	...
Methyl-orange alkalinity	154	225	159	...
Chlorides	1,145	1,400	1,400	5,020
Oil	0	250	20	Nil
Sulfates	...	...	...	2,660
Ammonia ion	...	...	...	313
Cresols	...	...	...	Nil

* All figures are given in parts per million

Treatment of Light Distillates By the SO_2 Extraction Process

By P. OBERGFELL*
E. B. Badger & Sons Co.

Physical aspects of the improved Edeleanu process are reviewed. Data from pilot plant and commercial plant operations is summarized for treating naphthas, kerosenes, gas oils and Diesel fuels for product improvement. A possible application is seen in the treatment of catalytic cracking re-cycle stock to remove the aromatics, thus increasing the capacity for virgin feed stocks. The engineering design of a modern SO_2 extraction plant is described and its utility requirements are given.

THE development of Middle Eastern petroleum resources in recent years has renewed refiners' interest in the SO_2 extraction process, which is indispensable for the manufacture of premium-grade kerosene from these crudes. This process also known by the name of the inventor, Dr. L. Edeleanu, is the oldest of all solvent extraction processes applied to petroleum fractions, for its first commercial application dates back to 1912.

The Edeleanu process utilizes the selective solubility of liquid sulfur dioxide for certain constituents of the petroleum fractions to be treated. The process comprises the following steps:

1. Contacting oil with solvent.
2. Separating the SO_2-soluble extract from the refined oil.
3. Recovering the solvent from extract and raffinate for re-use in the process.

Steps 1 and 2 are carried out in a counter-current type extraction tower filled with suitable packing. For recovery of the solvent from the raffinate and extract a series of evaporators is used, in which the oil is successively subjected to increasing temperatures at decreasing pressures.

The selective solvent action of the sulphur dioxide rests upon its rejection of aliphatic hydrocarbon at low temperature, while aromatic hydrocarbons are completely soluble in SO_2 at all temperatures. The solubility of naphthenic hydrocarbons is only slightly greater than that of the aliphatics, but it increases more rapidly with rising treating temperature. The degree to which naphthenes and paraffines are dissolved in the SO_2 depends upon the boiling range of the hydrocarbons and the temperature of extraction. For the same degree of concentration of aromatics in the extracts lower boiling petroleum fractions will require a lower treating temperature.

The high specific gravity of SO_2 makes for rapid and complete separation of the phases in the extraction tower. As a consequence high flow rates can be maintained in the tower. The solvent is completely stable up to temperatures far beyond those used in the recovery of the solvent. Since SO_2 boils at 14° F. it is easily recovered even from the lightest hydrocarbon fractions ordinarily handled in SO_2 plants.

The low specific and latent heat of the SO_2 are important factors in the heat economy of the plant. The low boiling point makes the solvent suitable as refrigerant. Thus the solvent can be cooled by self-refrigeration, and common compressors and condensers can be used for refrigeration and solvent recovery. A large part of the heat requirements in the solvent recovery system can be satisfied with low pressure steam, which makes it possible to employ steam-driven compressors and to use the exhaust steam in the solvent recovery system. The more important physical properties of sulfur dioxide are listed below:

Boiling point	14° F
Vapor pressure at 100° F	70 psig
Specific gravity @ 60°	1.4
Specific heat of liquid @ 60°	.332 Btu/°F., lb.
Latent heat @ 0° F	170 Btu/lb.
Latent heat @ 100° F	148 Btu/lb.
Ratio of specific heats	1.255 @ 60°

At a cost of about 5c per pound, liquid sulfur dioxide is one of the cheapest solvents used in this country. In foreign countries Edeleanu plants are often equipped with small SO_2 production units to save the costs of transportation of the solvent.

SO_2 Treatment of Naphthas

In the treatment of naphthas the desired product may be highly paraffinic raffinate or the aromatic extract, or both. One application of the process has been the manufacture of high anti-knock blending fuels. For this purpose it is advantageous to treat only the heavier naphtha fraction and to blend the extract from the latter with the untreated lower boiling fraction. The raffinate may be used in kerosene or may be charged to a reformer.

Of greater importance is the use of the process for the manufacture of paint and lacquer solvents or of solvents for the dry cleaning, printing, and rubber industry. Dependent upon the nature of the charge and the treating conditions, the treat-

Sulfur Dioxide Plants in the U. S.

Company	Plant Location	Design Capacity, BPSD, and Nature of Charge Stock(1)	
General Petroleum Corp.	Torrance, Cal.	5000	N-K-GO
Humble Oil & Rfg. Co.	Baytown, Texas	6000	N-K
	Baytown, Texas	7000	N
Shell Oil Co.	Martinez, Cal.	2000	N-K
	Martinez, Cal.	1750	L
	Wilmington, Cal.	5000	N-K
	Wood River, Ill.	1500	N-K
Standard of California	Richmond, Cal.	3000	K
	El Segundo, Cal.	7000	N-K-GO
The Texas Co.	Port Arthur, Tex.	1000	K-L
Tide Water-Associated Oil Co.	Avon, Cal.	3200	N-K-L
	Bayonne, N. J.	2000	L
Union Oil Co.	Wilmington, Cal.	7000	N-K
	Oleum, Cal.	1500	L

(1) N-Naphtha; K-Kerosene; GO-Gas Oil; L-Lube Oil

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ment of the naphtha with SO_2 produces a paraffinic raffinate containing 1% to 3% of aromatics and an extract of an aromaticity of 60%-70%. The raffinates have a high aniline number and a low sulfur content while the aromatic extracts are of high solvency.

By adding an extract stripping step to the SO_2 extraction, extracts of close to 100% aromaticity can be obtained. This stripping step consists of the displacement of the naphtha paraffins by means of a paraffinic cut of different boiling range.

Arthur Lazar[1] has presented data on varnish and lacquer diluents made by SO_2 treatment of California distillates. Information on the production of high-octane blending stocks from South Texas, Mid-continent and Sumatra stocks is contained in an article by E. Saegebarth and his coworkers[2]. Thompson[3] has reported on the action of SO_2 on Middle Eastern benzenes at treating temperatures ranging from +30° F to −70° F. Defize[4] has made a comprehensive study of the SO_2 process and its application for the treatment of benzenes, kerosenes and lubes.

In the SO_2 treatment of naphthas used in the paint and varnish industries, treating rates of 50 to 100 vol. % SO_2 are ordinarily employed, and the extraction is common'y carried out at 0° to 10° F, although one p'ant operates with an extraction temperature of 60° F and others have been designed for treatment at −20° F. The effect of the treating temperature on the aromaticity of the extract has been reported on by Saegebarth[2], and Thompson[3] has presented triangular graphs showing the increased aromaticity of low temperature extracts. The aromatic content of the charge stock has little bearing on the purity of the extract obtainable, but for a given SO_2 treating rate the recovery of aromatics will be more complete with stocks of high aromaticity.

The relation between concentration of aromatics in the charge, SO_2 treating ratio and recovery of aromatics in the extract is illustrated in Fig. 1, which refers to the treatment of naphthas containing 10% and 30% of aromatics.

Table 1 shows the results of commercial SO_2 treatment of Mid-Continent and Middle-Eastern naphthas. The charge stocks used were straight-run, but the application of the process is not restricted to virgin stocks. One large commercial plant treats hydroformates of high aromaticity for the manufacture of special solvents and pure aromatics. However, in the treatment of cracked stocks containing diolefins certain precautions must be taken to prevent a reaction of these components with SO_2.

With the treatment of kerosenes the SO_2 raffinate will be the desired product, but in many instances the aromatic character of the extracts makes them valuable byproducts. The primary object of the treatment of kerosene is the removal of smoke-promoting aromatics and of sulphur and nitrogen-bearing compounds. The tendency of a kerosene to produce smoke when burning is commonly expressed in terms of smoke point, which is the maximum flame height in millimeters at which a kerosene will burn without smoking. The test is carried out under standard conditions and in standard equipment as described in the "Standard Methods" of the British Institute of Petroleum.[7]

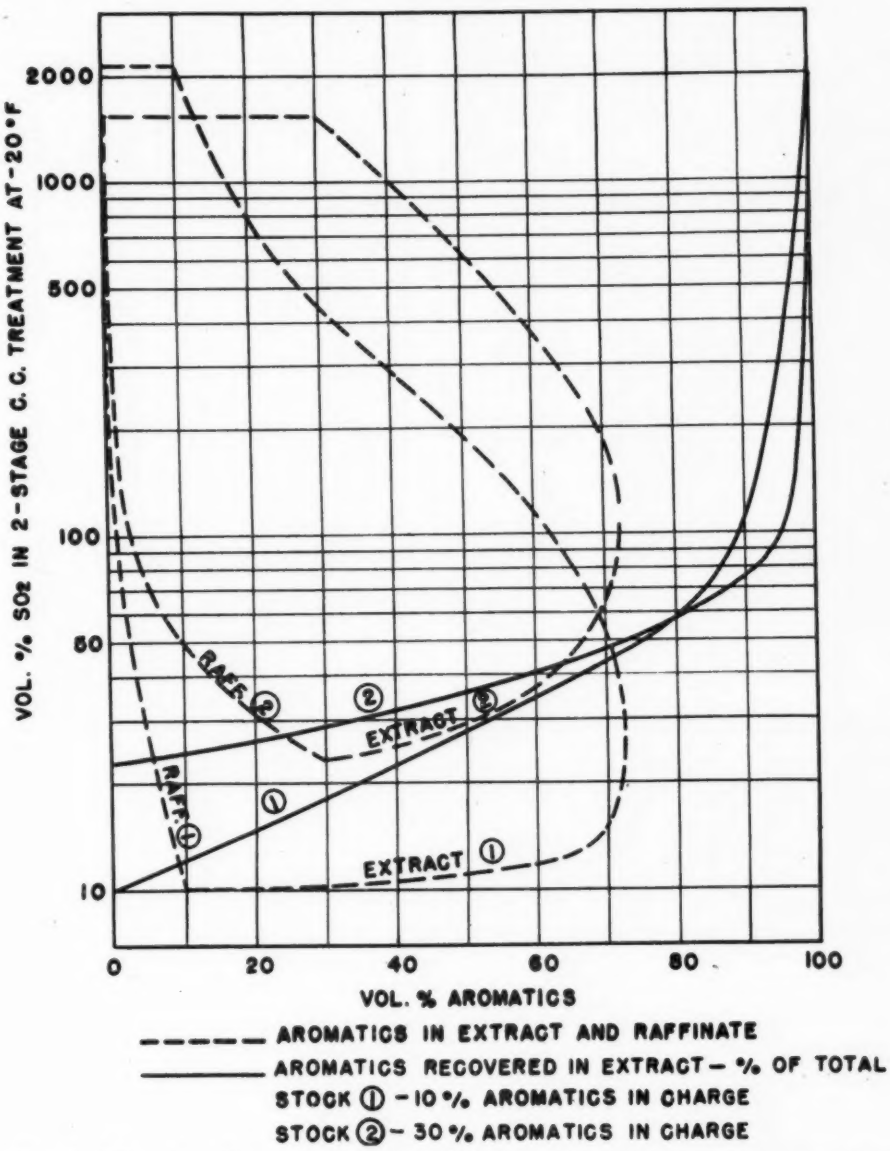


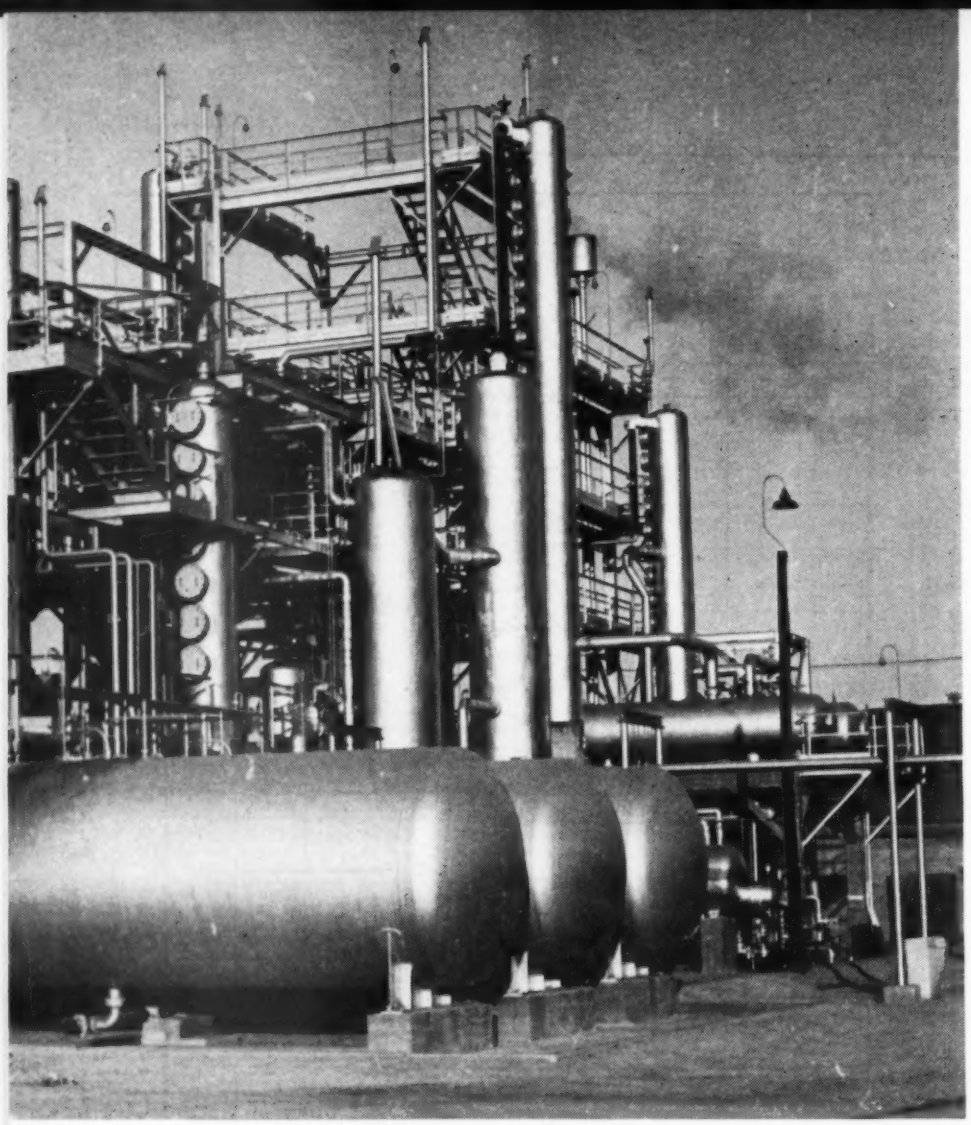
Fig. 1—SO_2 extraction of naphtha: Distribution of aromatics and recovery in extract

The smoke point of a paraffin base kerosene is usually over 30mm, while a lamp oil from an aromatic crude will have a smoke point below 18mm. Most Middle Eastern kerosenes have smoke points of about 24-25 mm. Conventional acid treatment will have practically no effect upon the smoke point, which can only be raised by removal of the bulk of aromatics.

The SO_2 extraction produces a kerosene raffinate with an aromatic

TABLE 1—SO_2 Treatment of Virgin Naphthas

	Mid-Continent 220-320° F ASTM 75 Vol. % SO_2 @ −15° F			Middle Eastern 200-300° F ASTM 77 Vol. % SO_2 @ −13%		
	Charge	Raff.	Extract	Charge	Raff.	Extract
° API	57.1	59.8	37.2	56.7	61.8	39
Yield, Vol. %	100	89	11	100	80	20
Aromatics, Vol. %	9.4	1.65	72	14.6	1.3	68
Anil. Pt. ° F	127	141	2			
Color, Saybolt		30+	10			
ON, CFR						83.7



Sulfur Dioxide Extraction

Central structure of modern SO_2 extraction unit of General Petroleum Corp. at the Torrance, Cal., refinery. Tanks in foreground are for SO_2 storage; in background the drying tower and extract evaporators

content of a few percent only and may raise the smoke point by as much as 10-15 points, dependent upon the nature of the stock and the severity of the treatment. The total sulfur content of the kerosene is reduced to a fraction of the original sulfur. The degree of sulfur removal depends to a large extent upon the nature of the sulfur compounds. Mercaptan sulfur is less affected than are cyclic sulfur compounds[5], so that it is usually necessary to sweeten the SO_2 raffinate.

The treatment of kerosenes is usually carried out at temperatures from 10° to 20° F and requires between 50% and 100% of SO_2. The SO_2 extracts have a higher concentration of aromatics than those from lower boiling stocks. Concentrations of 75% to 80% are obtained with treatment at 0° F. The lower boiling fractions of such extracts may be used as solvent naphthas or as blending agents to increase the octane rating of gasoline. As with naphthas, the extracts may be re-treated with a paraffinic solvent to produce an aromaticity up to 100%.

Tables 2 and 3 show the results of commercial treatment of different stocks. The data on California stock contained in Table 2 have been taken from a recent article of Dickey[6].

Fig. 2 refers to a typical Middle Eastern kerosene and illustrates the relation between the severity of the treatment and the quality of the raffinate in terms of smoke point, sulfur content, and concentration of aromatics.

SO_2 Treatment of Gas Oils

In the treatment of petroleum fractions in the gas oil range, the SO_2 extraction process has found extensive application for the manufacture of high-grade Diesel fuels. The primary object of the treatment is the removal of aromatic constituents which prolong the ignition period. Additionally, the solvent treatment removes sulfur-bearing and carbon-forming substances.

With the constantly expanding demand for Diesel fuels and the simultaneous shrinking of the supply of virgin gas oil due to the competition of catalytic cracking for this stock, it will become increasingly necessary to upgrade cracked stocks for use as first-grade Diesel fuels. While the refiner may often be able to make a Diesel fuel of acceptable ignition characteristics from such stocks by the use of suitable additives, this expedient will not solve problems such as exhaust odor and smoke, engine deposit, etc.

The extraction process, on the other hand, improves the overall quality of the Diesel fuel with the exception of the pour point, which may slightly increase in extraction due to the concentration of paraffinic constituents in the raffinate. However, with cracked stocks, meeting pour point specifications presents no problem, and on both cracked and virgin distillates the SO_2 extraction has been found to increase the response of the fuel to the addition of pour point depressors.[8]

The effect of SO_2 extraction on Diesel fuels has been studied by Woods[9], Dryer et al.[8], Steffen and Saegebarth[10] and others. Most of these older data refer to laboratory batch treatments. Dickey[6] has recently reported on the commercial treatment of straight-run gas oils from California crudes.

Table 4 shows the effect of SO_2 treatment on a light virgin Diesel oil stock from the Middle East. The data referring to treatment at 80° F are of academic value only, as it

TABLE 2—SO_2 Treatment of Kerosenes

	Mid-Continent 95 Vol. % SO_2 @ —8° F			California 100 Vol. % SO_2 @ +8° F		
	Charge	Raff.	Extract	Charge	Raff.	Extract
° API	42.8	46.3	22.9	38.4	42.5	26.8
Yield, Vol. %	100	86	14	100	76.5	23.5
Arom, Vol. %	14	2.6	85	18	2	75
Anil. Pt., ° F	151	200		128.8	156	
Sulfur, Wt. %				.19	.05	
Smoke Pt., mm				18	27	
Color, Saybolt				14	30+	

TABLE 3—SO_2 Treatment of Kerosenes

	Venezuela 65 Vol. % SO_2 @ 14° F			Iraq 100 Vol. % SO_2 @ 7° F		
	Charge	Raff.	Extract	Charge	Raff.	Extract
° API	41.3	45.0	27	46.9	50.9	30.7
Yield, Vol. %	100	81	19	100	82	18
Color, Saybolt	13	30				
Smoke Pt., mm	20	29				
Sulfur, Wt. %	.254	.046		.3	.045	1.3
Octane, CFR			84			
Arom. Vol. %				15	2.0	74.1

should not be necessary to keep the treating temperature more than about 5° above the pour point of the raffinate. It is of interest, however, to note that even at 80° F. the solvent still exhibited a fair degree of selectivity.

The SO_2 process is effective with virgin as well as cracked gas oils, but the relative improvement is especially pronounced with the latter. The yield of SO_2 raffinate will be dependent upon the nature of the charge. With non-olefinic charge stock it can be assumed that treatment with 100 vol % SO_2 at 20°-30° F. will furnish a raffinate containing some 3%-5% of aromatics and an extract of an aromaticity of 70-80 vol %. If further enrichment of the extract is desired, the extract phase may be cooled to a lower temperature with or without removal of some of the solvent in this phase. For more or less complete removal of all paraffinic constituents from the extract, stripping with a lower boiling paraffinic hydrocarbon may be employed.

Naphthenic acids present in the charge will concentrate in the extract and may be recovered therefrom as indicated by Dickey[6]. The raffinates will need no further treatment other than removal of the last traces of SO_2, which may be done chemically or by blowing with air. In some instances clay-straining of the raffinate has been resorted to for removal of traces of soaps which may clog injection orifices.

A possible application of the Edeleanu process of interest to the operators of catalytic cracking plants is the treatment of cycle stock for the purpose of increasing the capacity of the cracking unit. Since the Edeleanu extracts are composed mostly of very refractory polycyclic aromatics, their removal from the cycle stock will release cracking capacity for virgin stocks with attendant increased production of gasoline. Simultaneous production of some high-grade Diesel oil from this cycle stock should improve the overall economics of this particular application of the process.

The use of the SO_2 process for making insecticidal spray oils and transformer oils from California distillates has been reported on by U. B. Bray[11]. The treatment of these stocks requires usually 125% of SO_2 and more.

Modern Edeleanu Plant

Compared with older installations the modern Edeleanu plant operates at considerably higher temperature levels in the solvent recovery system, with attendant reduction of the size of the gas compressing equipment. As to the compressors themselves, centrifugal machines have lately been used successfully in SO_2 service. In plants of a charge capacity exceeding some 6000 BPSD the use of centrifugal compressors makes possible considerable savings. In both the reciprocating and the centrifugal design the use of special vented packing is standard practice today. With this arrangement leakage of SO_2 to the surrounding atmosphere or the entry of air into the machine has been stopped completely.

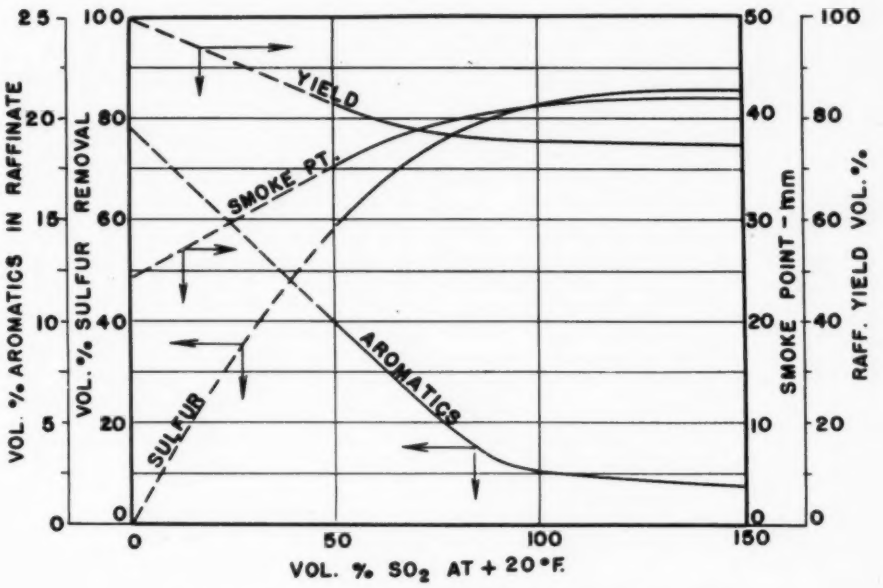


Fig. 2—SO_2 treatment of Middle Eastern kerosene

In an SO_2 extraction plant the control of the moisture content of the circulating solvent is of prime importance. Considerable emphasis is placed on the removal of water from the charge stock. Calcium chloride filters preceded by a coagulator have taken the place of the old rocksalt filters. Drying of naphtha and kerosene charge by distillation has been investigated and has been found to be most effective, although somewhat higher in cost than drying by absorption.

In the design of the water-solvent fractionating system extensive studies on the behavior of different stainless steels have furnished valuable information. Aside from the material composition and heat treatment of the stainless steel, the physical design of this equipment has been found to make much difference in the life of the apparatus involved.

In spite of the corrosive nature of the combination of SO_2 and water, stainless steel only is used in the water-SO_2 fractionating column and in valve and pump trim. The service factor of a modern Edeleanu plant is very high, often close to 98%, and the equipment is long-lived. Compressors installed in Edeleanu plants some 25 years ago are still in service today.

The designers of SO_2 plants have made use of the latest developments in instrumentation. Displacement-type liquid level controllers have proved valuable due to the elimination of stuffing boxes. In the control of small reflux streams rotameters with remote control have given good service. This type of controller does away with the instrument leads which often required elaborate means for purging. Close automatic control of reboiler temperatures has reduced the losses of solvent in the products to mere traces. For the protection of the equipment against a failure in water-cooled or steam-heated equipment, conductivity and pH alarms are provided. The purging of fixed gases from the condensers has been facilitated by the use of a recorder for the partial pressure of noncondensibles.

Edeleanu plants are most commonly built to handle stocks from light lube oils down to light naphtha. This flexibility adds only a small percent-

TABLE 4—SO_2 Treatment of High-Speed Diesel Oil Stock from Middle Eastern Crude

Treating Temp.		30° F		80° F	
Treating Ratio, Vol. %		80	160	80	163
	Charge	Raffinate		Raffinate	
° API	36.9	41.4	42.3	41.2	42.2
Yield, Vol. %	100	83.8	80.5	76.9	72.1
IBP ° F	449	...	...	...	...
FBP ° F	698	...	...	...	...
Total Sulfur, Wt. %	.665	.173	.104	.189	.104
Pour Pt., ° F	15	20	20	20	25
Aniline Pt., ° F	167	186.8	189.5	187.5	192.2
Diesel Index	61.2	77.2	80.2	77.2	81.1

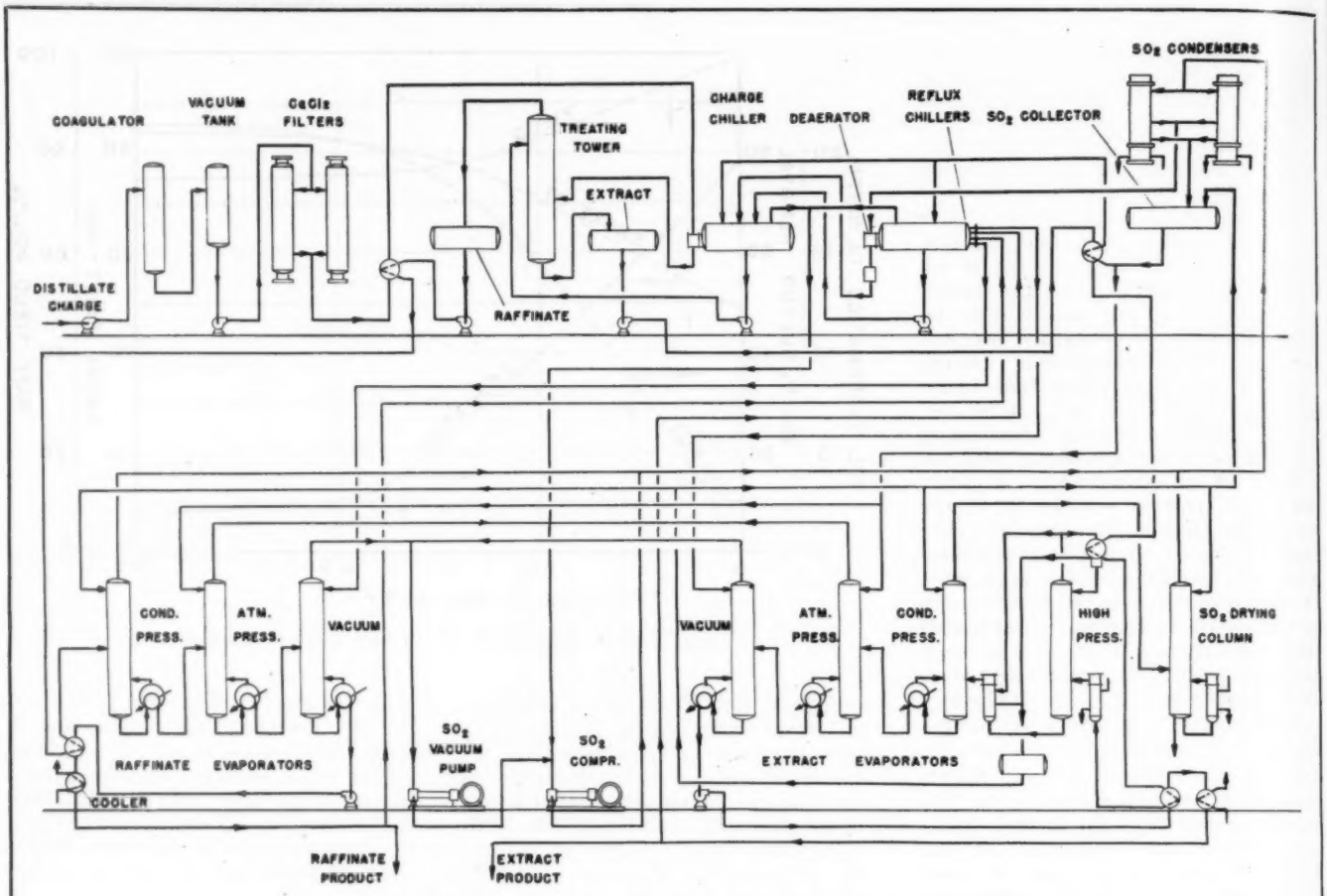


Fig. 3—Schematic flow diagram of a modern SO_2 extraction plant

age to the cost of the plant and is of obvious advantage to the refiner. Switching from one charge stock to another can be done without shutting the unit down, and it takes usually not more than four hours to obtain specification products from the new stock.

Fig. 3 is a schematic flow diagram of an SO_2 extraction plant of standard design for the treatment of naphthas, kerosene and gas oils. A plant of similar design has been described in considerable detail by Dickey[6].

Operating Requirements

The SO_2 process requires heating steam for the recovery of the solvent, power for pumps and compressors and water for product coolers and solvent condensers. Where electric power is inexpensive and the refinery makes an excess of exhaust steam, it will be of advantage to use motor-driven compressors. In areas with abundant supply of cheap fuel gas the compressors may be gas-driven. Where no low pressure steam is available, it will usually be of advantage to use steam-driven compressors, provided the live steam pressure is sufficiently high so that the plant can utilize in the driving end of the compressors all or most of the exhaust steam made. With centrifugal compressors steam turbines are preferred because suction pressure control by speed regulation increases the capability of the compressor to take fluctuation in load without resort to gas recirculation.

The tabulation of estimated utility requirements presented in Table 5 is based on plants of medium size. The power consumption of the SO_2 compressors has been given as a separate item, to facilitate conversion into steam consumption if the required low pressure steam is to be produced in the SO_2 plant itself. The higher live steam and lower LP steam figures given refer to the use of live steam in all reboilers. In order to improve the steam balance with steam-driven compressors, low pressure steam may be substituted for part of the demand of live heating steam, with an attendant slight increase of cost for reboilers of larger size.

The loss of SO_2 can be assumed to be about .15 lbs. per barrel of charge. In very small plants the required solvent make-up may run somewhat higher. The consumption of calcium chloride will be approximately .05 to .1 lb/bbl of charge. Two operators per shift and a day-shift supervisor are usually required to run an SO_2 plant.

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TABLE 5—Utility Requirements of Straight SO_2 Extraction Plants

(All figures refer to one barrel (42 U.S. gals) of charge)

Charge Stock	Naphtha	Kerosene	Gasoil
SO_2 Treatment	75 Vol. %	100 Vol. %	125 Vol. %
Treating Temp.	0° F	14° F	30° F
Live steam to Process Heating	18-28 lbs	20-30 lbs.	20-30 lbs.
Low Press. Steam to Process Heating	45-35 lbs.	55-45 lbs.	65-55 lbs.
Pumping Power & Lighting	1.0 KWH	1.15 KWH	1.15 KWH
Power for Compressors	2.50 KWH	1.85 KWH	1.70 KWH
Cooling Water, 85° F	750 gals.	830 gals.	930 gals.

Effect of Thermal Expansion on Capacity Of Large Vertical Storage Tanks

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AS POINTED OUT in an earlier article* one of the troublesome problems in the oil industry is that of keeping an accurate inventory in large storage tanks. Inventories have a tendency to gain during the summer months and to lose during the winter months—despite whatever precautions are taken to assure accurate gage readings.

Two factors which usually are ignored in tank calibration and gaging because they are considered negligible have been investigated to determine what effect they have on tank inventories:

1. The change in capacity of a tank due to stretching from the pressure of the liquid in the tank.
2. The change in capacity of a tank due to thermal expansion and contraction of the tank itself.

The previous article* discussed the first factor—effect of fluid pressure. The present article is concerned with the second factor—the effect of temperature changes on the tank itself. Only vertical storage tanks are considered.

Effects of Temperature Changes

When the temperature of a piece of ordinary metal is changed, the size of the piece changes in accordance with the metal's coefficient of expansion. Therefore, when the atmospheric temperature changes, the shell of a metal storage tank will become warmer or cooler and will expand or contract, and the capacity of the tank will be proportionately greater or lesser.

The purpose of the following analysis is to develop formulae to determine easily the magnitude of this change, and whether or not it is an appreciable factor. It is assumed that the temperature of the shell and the temperature of the liquid in the tank are the same.

Consider the customary procedure of strapping and calibrating a vertical storage tank. The periphery of the tank is measured carefully at various points from top to bottom with a steel tape. The thickness of the plates is measured, and the height of each ring recorded. From this data the content of each inch of depth is computed and recorded on the calibration chart.

The tape used in this work is almost certain to be made of material with a very low coefficient of expansion. The steel in the tank shell, on the other hand, has an appreciable coefficient of expansion. If we assume that the tape is correct at all atmospheric temperatures or that temperature corrections were made for the length of the tape, it would be obvious that a tank chart computed as described is correct only at the temperature at which the measurements were made.

For the purposes of this analysis, let:

T_1 = temperature of the liquid in a tank (and therefore the temperature of the tank shell itself) at any given time, in degrees F.
T_2 = temperature at which the tank was calibrated.
D = diameter of the tank, in feet.
L_T = change in tank circumference due to temperature change, in inches.
R_T = change in tank radius due to temperature change, in inches.
V_T = change in tank inventory due to temperature change of the tank itself, in gallons.
H = height of liquid in the tank, in feet.

The value $T_1 - T_2$, then, is the difference between the temperature of the tank at the time of taking inventory and at the time when the tank was calibrated, and is the temperature difference for which calibration corrections are to be computed. The value is negative when T_1 is less than T_2, that is, during cooler weather.

According to the laws of physics, the change in length of a piece of metal for a given change in temperature is equal to the thermal coefficient of expansion of the metal, times the temperature difference in degrees F., times the length of the piece. For a tank shell with a coefficient of expansion of 6.7×10^{-6} this change in length may be written as:

$$L_T = 0.0000067\,(T_1 - T_2)\,(12\pi D)$$

and the change in tank radius is then:

$$R_T = \frac{L_T}{2\pi} = 0.0000067\,(T_1 - T_2)6D$$

Where the ratio of the increase in tank radius to the tank diameter is very small (as in this case), the increase in tank capacity for each inch of depth can be very closely approximated by multiplying the increase in tank radius (in inches) by the circumference of the tank (in inches). The change in tank inventory, then, can be computed by multiplying the increase in tank capacity for one inch by the depth of liquid in the tank (in inches). The resulting value will be in cubic inches, which can be converted to gallons by dividing by 231, so that:

$$V_T = \frac{R_T \times 12\pi D \times 12H}{231}$$

$$= \frac{0.0000067\,(T_1 - T_2)\,6D \times 12\pi D \times 12H}{231}$$

$$= 0.000078725\,(T_1 - T_2)\,D^2H$$

or

$$V_T = \frac{D^2H\,(T_1 - T_2)}{12700}$$

for any depth of liquid (H, in feet), and

$$V_T = \frac{D^2\,(T_1 - T_2)}{152{,}400}$$

for a ring of liquid one inch high.

The last formula can be used to compute the change in inventory due to a change in temperature of the tank for one inch of liquid height. In order to visualize more clearly the meaning of this equation when applied to various size tanks, an alignment chart has been prepared for its graphic solution—Fig. 1.

Now let us consider a specific case and determine what effect thermal expansion of the tank has on inventory.

Assume a tank 100 ft. in diameter by 42 ft. high, which was strapped when the temperature of the shell was 68° F. The tank has exactly 40 ft. of liquid in it, and the calibration or gage chart shows 2,356,200 gallons. The temperature of the liquid is 38° F.

In this case the temperature difference = 68° − 38° = 30° F. By formula (or chart) each inch of the tank holds 1.97 gals. less than the chart indicates. In the total depth of liquid content of the tank, 40 ft., this loss amounts to 40 × 12 × 1.97, or 945.6 gals. that *are not there*. The gager reports 2,356,200 gals. on hand, when the true inventory is 2,355,255 gals.

If the amount of product delivered to the tank is determined by the calibration chart and the amount of product dispensed is measured by some external means (such as a

* "Effect of Fluid Pressure on Capacity of Vertical Storage Tanks," by W. E. Splain, PETROLEUM PROCESSING, Oct., 1948 (vol. 3, no. 10), pg. 937.

Effect of Thermal Expansion

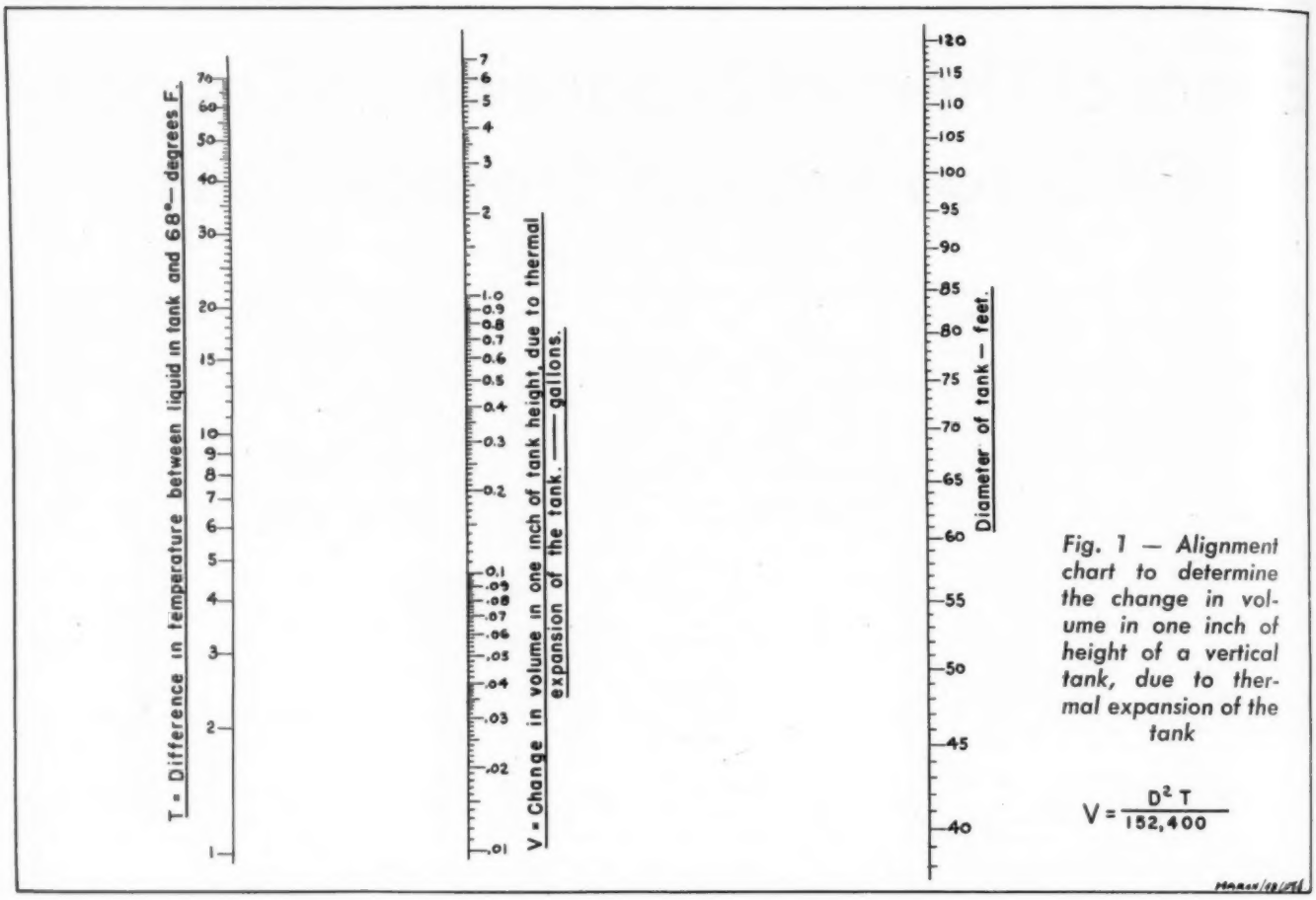
T = Difference in temperature between liquid in tank and 68°— degrees F.
V = Change in volume in one inch of tank height due to thermal expansion of the tank. — gallons.
Diameter of tank — feet.
V = D² T / 152,400

Fig. 1 — Alignment chart to determine the change in volume in one inch of height of a vertical tank, due to thermal expansion of the tank

meter, tank truck of known capacity, etc.) the tank will show an accumulated shortage in cold weather and an accumulated gain in warm weather.

It is now necessary to develop a practical means whereby a storage man can correct daily for tank variations without resorting to complex calculations. The development of such a formula for a correction factor follows:

The area of a horizontal plane through a tank at the temperature at which it was calibrated $= \pi D^2/4$ sq. ft., $= 36\pi D^2$ sq. in.

The change in tank radius due to temperature change, as previously developed, $= R_T = 0.0000067\ (T_1 - T_2)\ 6D$.

Tank circumference, in inches, $= 12\pi D$.

The increase in area of a horizontal section of a tank at any temperature equals the radius increase times the circumference,

$$= [0.0000067\ (T_1 - T_2)\ 6D] \times 12\pi D$$
$$= 0.0000067 \times 72\pi D^2\ (T_1 - T_2)$$

The ratio of the area of a horizontal section of the tank at any temperature to the area at the calibration temperature is then:

$$= \frac{(36\pi D^2) + [0.0000067 \times 72\pi D^2\ (T_1 - T_2)]}{36\pi D^2}$$
$$= 1 + 0.0000067 \times 2(T_1 - T_2)$$
$$= 1 + 0.0000134\ (T_1 - T_2)$$

This last value then is the multiplying factor which corrects calibration chart readings for changes in tank size due to thermal expansion or contraction.

If the temperature at which the tank was calibrated is known or can be determined, a simple table of factors can be prepared. Table 1 is such a table, computed for tanks calibrated at 68° F. Since the factors depend upon temperature differences, it should be evident that by placing the temperature at which the tank was calibrated opposite the factor 1,000,000 and arranging the temperature scale from that point, the table can be adapted to any tank.

Conclusions

The following conclusions are suggested by the above analysis:

1—Where accurate gaging of large diameter tankage is required, the effect of thermal expansion of the tank may become an appreciable factor.

2—The effect is more pronounced in large diameter tanks, since the change in capacity varies as the square of the tank diameter.

3—The effect on inventory is accumulative and seasonal.

It is further suggested that when large vertical tanks are calibrated:

1—Corrections be made for temperature of the tank shell so that the calibration chart will be correct at some definite temperature.

2—A table of multiplying factors be provided the gager to compensate for thermal expansion and contraction of the tank.

TABLE 1—Temperature Correction Factors for Tank

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
0	0.9990888	20	0.9993568	40	0.9996248	60	0.9998928	80	1.0001608
1	0.9991022	21	0.9993702	41	0.9996382	61	0.9999062	81	1.0001742
2	0.9991156	22	0.9993836	42	0.9996516	62	0.9999196	82	1.0001876
3	0.9991290	23	0.9993970	43	0.9996650	63	0.9999330	83	1.0002010
4	0.9991424	24	0.9994104	44	0.9996784	64	0.9994640	84	1,0002144
5	0.9991558	25	0.9994238	45	0.9996918	65	0.9999598	85	1.0002278
6	0.9991692	26	0.9994372	46	0.9997052	66	0.9999732	86	1.0002412
7	0.9991826	27	0.9994506	47	0.9997186	67	0.9999866	87	1.0002546
8	0.9991960	28	0.9994640	48	0.9997320	68	1.0000000	88	1.0002680
9	0.9992094	29	0.9994774	49	0.9997454	69	1.0000134	89	1.0002814
10	0.9992228	30	0.9994908	50	0.9997588	70	1.0000268	90	1.0002948
11	0.9992362	31	0.9995042	51	0.9997722	71	1.0000402	91	1.0003082
12	0.9992496	32	0.9995176	52	0.9997856	72	1.0000536	92	1.0003216
13	0.9992630	33	0.9995310	53	0.9997990	73	1.0000670	93	1.0003350
14	0.9992764	34	0.9995444	54	0.9998124	74	1.0000804	94	1.0003484
15	0.9992898	35	0.9995578	55	0.9998258	75	1.0000938	95	1.0003618
16	0.9993032	36	0.9995712	56	0.9998392	76	1.0001072	96	1.0003752
17	0.9993166	37	0.9995846	57	0.9998526	77	1.0001206	97	1.0003886
18	0.9993300	38	0.9995980	58	0.9998660	78	1.0001340	98	1.0004020
19	0.9993434	39	0.9996114	59	0.9998794	79	1.0001474	99	1.0004154

Short Cut Process Design to Increase Propane Recovery in Gasoline Plants

By ALAN S. GLENDENING and CHARLES F. SANDERSON
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Article 6: Multi-Stage Distillation, Calculations

Last month the authors discussed the application of multi-stage distillation to a high recovery gasoline plant, to reduce or eliminate the excessively large volumes of non-condensible surge tank vapors which may result when a conventional absorption oil system is employed.

In the current article they present a set of calculations, which show that a 25 BHP recompressor is satisfactory in a hypothetical plant using multi-stage distillation, although the same plant would require a 300 BHP recompressor if conventional single stage distillation were used.

IN AN EARLIER ARTICLE in this series on refrigerated oil absorption (Article 4, April, pg. 401), a high propane recovery sample calculation was carried out. It was found that an extremely large recompressor was required with a conventional distillation system to compress surge tank vapors to the deethanizer column.

By way of comparison, the same rich oil from the main absorber will be processed in a two-stage system, such as was shown in Fig. 19 last month (Article 5, May, pg. 530), and the recompressor requirements compared with those determined in the previous calculation.

From the preceding problem, main absorber rich oil composition was:

Component	Mols/hr.
Methane	115.5
Ethane	83.7
Propane	126.7
iso-Butane	29.7
n-Butane	93.2
iso-Pentane	22.0
n-Pentane	37.4
Hexane +	28.6
	536.8
Oil	171.8
	708.6

This 500 psig. rich oil will be flashed cold and then flashed hot prior to re-absorption, as in Fig. 21 (Article 5, May, pg. 533). The high pressure still will run at 150 psig. With a 50 psi. drop through lines, valves, part of the oil exchangers, and still preheater, the re-absorber will run at 200 psig. Allowing about a 5 psi. drop through the hot flash vapor cooler, the hot flash will take place at 205 psig. Allowing an additional 15 psi. drop through the remaining bank of oil exchangers, the cold flash occurs at 220 psig.

The same re-absorber oil circulation will be used as in the preceding sample calculation (114.6 mols/hr.). Absorption oil of 180 mol wt., 40° API will be available as before. Rich oil leaves the main absorber at 500 psig. and 66° F. The hot flash will be assumed to take place at 180°. A maximum temperature of 400° in the distillation system will be assumed. MIT K's will be used throughout.

The results of the flash calculations are shown in Table 9, and were obtained by the usual equilibrium calculation method. A 3° temperature drop from the main absorber to the cold flash was assumed. The average K of absorption oil was assumed to be negligible.

The hot flash vapors will now be cooled and partially condensed at 200 psig. and 90°. This calculation is shown in Table 10.

The vapor remaining after partial condensation is combined with the cold flash vapor to give total vapor to the re-absorber. The amount of this vapor is 110.1 + 114.7 = 224.8 mols/hr. The re-absorber will be figured on the basis of absorption factors at the bottom tray according to the method of Sherwood,(1) and will be assumed to contain 7.2 theoretical plates as in the previous sample calculation. No graphical corrections (a part of Sherwood's method) will be considered since such corrections will be small. The relation between the absorption factors and percent absorbed of each component will be obtained from an absorption factor chart(2) based on the Kremser formula.(3) The absorption factor = L/KV where L/V is the liquid to vapor ratio at the bottom tray. A bottom tray temperature of 115° will be assumed. Mols lean oil to the re-absorber = 114.6.

Assume 72 mols absorbed, then L/V = (114.6 + 72.0)/224.8 = 0.828. The calculation of the mols re-absorbed is shown in Table 11.

The computed total mols re-absorbed (72.2) checks well with the assumed value (72) so no further re-absorption calculation is necessary.

The re-absorber rich oil now will be combined with the condensed li-

TABLE 9—Rich Oil Dual Flash Calculations

		Cold Flash			Hot Flash	
	K at 220 psig and 63°	Vapor	Liquid	K at 205 psig and 180°	Vapor	Liquid
Methane	9.8	75.4	40.1	19.0	34.4	5.7
Ethane	1.76	21.2	62.5	4.5	36.8	25.7
Propane	.59	12.9	113.8	1.72	40.3	73.5
iso-Butane	.25	1.4	28.3	.95	6.6	21.7
n-Butane	.185	3.1	90.1	.78	17.9	72.2
iso-Pentane	.071	0.3	21.7	.41	2.5	19.2
n-Pentane	.053	0.4	37.0	.34	3.6	33.4
Hexane +	.005	...	28.6	.07	0.6	28.0
		114.7	422.1		142.7	279.4
Oil		....	171.8		....	171.8
		114.7	593.9		142.7	451.2

TABLE 10—Cooling of Hot Flash Vapors

	Vapor to Cooler	K at 200 psig. and 90°	Liquid	Vapor
Methane	34.4	12.5	0.8	33.6
Ethane	36.8	2.39	4.1	32.7
Propane	40.3	.84	10.6	29.7
iso-Butane	6.6	.39	2.9	3.7
n-Butane	17.9	.29	9.1	8.8
iso-Pentane	2.5	.12	1.8	0.7
n-Pentane	3.6	.095	2.7	0.9
Hexane +	0.6	.01	0.6	...
	142.7		32.6	110.1

TABLE 11—Calculation of Mols Re-absorbed

	Vap. to Reabs.	K at 200 psig. and 115°	Abs. Fact. $= 0.828/K$	% Abs.	Mols Abs.
Methane	109.0	14.3	.0579	5.79	6.3
Ethane	53.9	2.9	.286	28.6	15.4
Propane	42.6	1.07	.774	73.7	31.4
iso-Butane	5.1	.53	1.562	98.4	5.0
n-Butane	11.9	.41	2.02	99.4	11.8
iso-Pentane	1.0	...	...	100.0	1.0
n-Pentane	1.3	...	...	100.0	1.3
Hexane +	...	...	...	...	...
	224.8			...	72.2

TABLE 12—Vaporization of Feed to H.P. Still

	Total Rich Oil to H.P. Still	K at 150 psig. and 400°	Liquid Part of Feed	Vapor Part of Feed
Methane	12.8	52.0	0.3	12.5
Ethane	45.2	18.1	2.5	42.7
Propane	115.5	7.9	13.9	101.6
iso-Butane	29.6	4.9	5.4	24.2
n-Butane	93.1	4.1	19.4	73.7
iso-Pentane	22.0	2.5	6.6	15.4
n-Pentane	37.4	2.3	12.0	25.4
Hexane +	28.6	1.0	14.9	13.7
	384.2		75.0	309.2
Oil	286.4	.046	275.0	11.4
	670.6		350.0	320.6

TABLE 13—Component Distribution in H.P. Still

	K at 150 psig. and 325°	α	d/w	Total Feed, f	Bottoms, w	K at 150 psig and 400°	wK
Methane	43.0	7.82	large	12.8	...	...	...
Ethane	13.0	2.36	large	45.2	...	...	...
Propane	5.5	1.00	31.0	115.5	3.6	7.9	28
iso-Butane	3.2	.581	1.85	29.6	10.4	4.9	51
n-Butane	2.7	.491	1.0	93.1	46.6	4.1	191
iso-Pentane	1.6	.291	.25	22.0	17.5	2.5	44
n-Pentane	1.46	.265	.22	37.4	30.6	2.3	70
Hexane	.87	.158	.11	14.3	12.9) 27.2	1.0	27
Heptane +	.31	.056	small	14.3	14.3)		
				384.2	135.9		411
Oil				286.4	286.4		13
				670.6	422.3		424

quid from the vapor cooler and the rich oil remaining after the hot flash to give total rich oil to the high pressure still. This total rich oil is then heated to 400° and fed into the H.P. still. Vaporization of this feed is shown in Table 12.

In the above, it was necessary to obtain an average K for absorption oil. This was done by assuming the vapor pressure of absorption oil to be 14.7 psia. at 450°, extrapolating along a vapor pressure chart to 400°, and computing K by means of the relation: K = oil vapor pressure/total pressure.

The component distribution and reflux rate in the H.P. still will now be computed. The top of this still will run at about 200° and the bottom at 400°, or the arithmetic average still temperature will be about 300°. However, since the stripping section temperature gradient will be almost flat (due to the presence of the absorption oil) the effective average tower temperature will be somewhat higher than 300°. Therefore 325° will be used as the average temperature. The relative volatilities at this temperature will be computed and a semi-log component distribution chart constructed as in Fig. 23. Several lines will have to be drawn on this chart before a bottom product of desirable composition is obtained. Initial trials indicate that the tower can be operated without process steam, so a line should be located in Fig. 23 such that the bottom product will be in equilibrium at 400° and 150 psig..

In order to obtain a first trial line, it is suggested that two components be used as keys and a straight line drawn between the two points on the chart corresponding to these keys. For instance, d/w (the ratio of component quantity in tops to component quantity in bottoms) for propane and hexane might be assumed to be 50 and 0.1 respectively. The bottoms composition corresponding to the line connecting these points would then be computed and checked with regard to the desired bottom conditions. The line would then be shifted somewhat until the desired bottom conditions were obtained.

In Table 13, α has been computed relative to propane and values of d/w have been obtained from the line given in Fig. 23. The composition of the bottoms has been computed by means of the relation: $w = f/(d/w + 1)$, where f is the total mols of a component in the feed. Equilibrium conditions at the bottom are checked in the last column. For convenience hexane + in the feed has been split on the assumption that half of it is hexane. It is recombined for the equilibrium calculation.

Since the summation of wK approximately equals total mols of bottoms, bottoms of the above composition will be in equilibrium at the desired conditions.

The vapor pressure of the absorbed components in the H.P. still bottoms must now be checked in order to determine the operating pressure of the L. P. still. If the latter should be more than about 40 psig., the H.P. still separation would have to be refigured on the basis of a less volatile bottoms. Such operation would, of course, require some H. P. still process steam unless the bottom temperature were raised above 400°.

From Table 14, vapor pressure of the L. P. still tops at 90° is (30) (131.6)/135.9 = 29 psia. Thus, the L.P. still reflux accumulator will operate at 14 psig. and, allowing a 6 psi. drop from the tower to the accumulator, the L.P. still will run at 20 psig. This is a satisfactory operating pressure, so the H.P. still separation was properly chosen.

Returning now to the H.P. still, the reflux rate must be determined. The total feed to the H.P. still will be broken into three portions: net overhead, absorbed components in the bottoms, and absorption oil. These will be referred to as D, W, and O respectively. From the above equilibrium check at the bottom of the H.P. still (400°), the average K of W at 400° is 411/135.9 = 3.03, or the K of W lies between those of n-butane and iso-pentane. By interpolating between the K's of n-butane and iso-pentane at 325°, a K of W equal to 1.964 is obtained at that temperature. K of O (absorption oil) will be very small at 325° and will be considered to be negligible. K of D (tops) may be obtained by subtracting WK_w from the summation of fK corresponding to the various com-

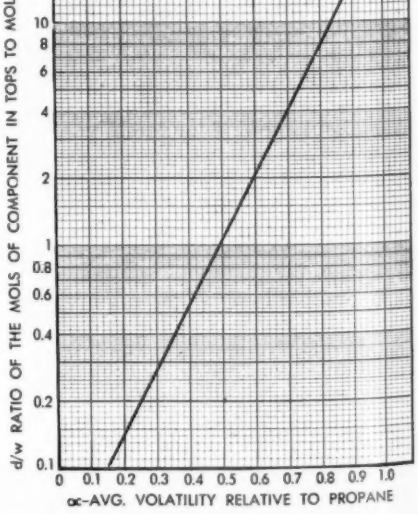

Fig. 23—Approximate component distribution, H.P. still

ponents in the feed, as in Table 15.

Relative volatilities will be computed with respect to W, and average mol fractions in the feed (z_f) obtained to give the "component" distribution shown in Table 16. This tabulation (Table 16) contains the information necessary to compute minimum reflux by means of Underwood's equations, which are:

$$R_{min} = [\Sigma \alpha Y_d/(\alpha - \theta)] - 1 \quad \ldots (30)$$

where:

R_{min} = minimum reflux ratio relative to tops.

y_d = mol fraction of any component in tops.

α = relative volatility of component at average tower conditions.

θ is a function whose value lies between the α's of the key components, and is given by:

$$\Sigma \alpha z_f/(\alpha - \theta) = 1 - q \quad \ldots (31)$$

where:

z_f = average mol fraction of a component in the feed.

q = thermal condition of the feed, defined by $q = (L_m - L_n)/F$, where L_m and L_n are mols liquid below and above the feed, respectively, and F is total mols feed.

From the definition of q, it is apparent that q is given approximately by the fraction of the feed which is in a liquid state. In this problem,

$$q = 350.0/670.6 = 0.522$$

and

$$1 - q = 0.478$$

θ lies between the α's of the key components and must be determined by a trial-and-error solution of Equation 31. The results of a trial with $\theta = 1.9$ are given in Table 17. Since the summation in the right hand column of this table checks with $1 - q$ as determined above, then $\theta = 1.9$ is correct.

Substituting this value in Equation 30 and noting that D is the only "component" in the tops and, consequently, $y_d = 1.0$:

$$R_{min} = [(4.01)\ (1.0)/2.11] - 1 = 0.90$$

Applying about a 10% factor to allow for less than infinite trays, use a reflux ratio of 1.0, or reflux = 248.3 mols/hr. Use a tower with about 18 trays.

H.P. still reflux and top temperatures will now be determined and the primary condenser duty computed. Dewpoint on the net overhead is shown in Table 18. In calculating the equilibrium, hexane + was assumed to be entirely hexane. Evidently the reflux temperature is slightly less than 140°. At K of n-butane equal to (0.65) (231.8)/248.3 or 0.61, temperature is 135°. This is the reflux temperature.

The right hand column in Table 18 gives reflux composition. Reflux is now computed, combined with the net overhead to give total material to the primary condenser, and a dewpoint run on this total material to obtain the top tray temperature as in Table 19.

At K of n-butane equal to (0.95) (484.8)/496.6 = 0.93, temperature is 177°. This is the temperature at the top tray and at the entrance to the primary condenser.

Total lbs. to condenser
= 11,269 + 14,355 = 25,624

Mol wt. material to condenser
= 25,624/496.6 = 51.6

Btu./lb. material to condenser at 177°
= 332

Lbs. reflux
= 14,355

Mol wt. reflux
= 14,355/248.3 = 57.8

Btu./lb. reflux at 135°
= 180

Lbs. net overhead
= 11,269

Mol. wt. net overhead
= 11,269/248.3 = 45.4

Btu./lb. net overhead at 135°
= 320

Condenser Heat Balance:

Heat in:
(25,624) (332) = 8,510,000 Btu./hr.

Heat out:
(14,355) (180) = 2,580,000
(11,269) (320) = 3,610,000
= 6,190,000 Btu./hr.

Primary Condenser Duty:
8,510,000 − 6,190,000
= 2,320,000 Btu./hr.

The duty of the H.P. still reheater will not be computed here.

The low pressure still steam consumption, reflux rate, and condenser

TABLE 14—Bubble Point Calculation on L.P. Still Tops

	L.P. Still Tops	K at 30 psia. and 90°	Tops times K
Propane	3.6	4.8	17.3
iso-Butane	10.4	2.0	20.8
n-Butane	46.6	1.48	69.0
iso-Pentane	17.5	.56	9.8
n-Pentane	30.6	.44	13.5
Hexane +	27.2	.045	1.2
	135.9		131.6

TABLE 15—Calculation of K_D

	Mols Feed, f	K at 150 psig and 325°	fK
Methane	12.8	43.0	550
Ethane	45.2	13.0	587
Propane	115.5	5.5	635
iso-Butane	29.6	3.2	95
n-Butane	93.1	2.7	251
iso-Pentane	22.0	1.6	35
n-Pentane	37.4	1.46	55
Hexane +	28.6	.5	14
	384.2		2222
Oil	286.4	negl.	....
	670.6		2222

WK_w at 325° = (135.9) (1.964) = 267, or $DK_D = \Sigma fK - WK_w - OK_o$ = 2222 − 267 − 0 = 1955.

$D = \Sigma f - W - O$ = 670.6 − 135.9 − 286.4 = 248.3 mols./hr., or K_D = 1955/248.3 = 7.87.

TABLE 16—"Component" Distribution

	"Component" in Feed	z_f	K at 150 psig. and 325°	α	Tops	Bottoms
D	248.3	0.370	7.87	4.01	248.3	....
W	135.9	0.203	1.964	1.00	....	135.9
O	286.4	0.427	negl.	negl.	....	286.4
	670.6	1.000			248.3	422.3

TABLE 17—Trial-and-Error Solution of θ

	z_f	α	αz_f	$\alpha - \theta$	$\alpha z_f/(\alpha - \theta)$
D	0.370	4.01	1.483	2.11	0.703
W	0.203	1.00	0.203	—0.90	—0.225
O	0.427	negl.	....	...	....
	1.000				0.478

TABLE 18—Dewpoint on H.P. Still Overhead

	H.P. Still Net Ov'h'd, mols/hr.	Net Ov'h'd, lbs/hr.	K at 150 psig. and 140°	Mols/K
Methane	12.8	205	21.2	0.6
Ethane	45.2	1360	4.47	10.1
Propane	111.9	4930	1.62	69.1
iso-Butane	19.2	1116	.83	23.1
n-Butane	46.5	2703	.65	71.6
iso-Pentane	4.5	325	.30	15.0
n-Pentane	6.8	490	.243	28.0
Hexane +	1.4	140	.098	14.3
	248.3	11269		231.8

TABLE 19—H.P. Still Top Tray Conditions

	Reflux, mols/hr.	Reflux, lbs/hr.	Mols/hr. to Cond.	K at 150 psig. and 180°	Mols/K
Methane	0.6	10	13.4	25.4	0.5
Ethane	10.8	325	56.0	5.85	9.6
Propane	74.0	3263	185.9	2.22	83.7
iso-Butane	24.8	1442	44.0	1.19	37.0
n-Butane	76.7	4460	123.2	.95	129.9
iso-Pentane	16.1	1161	20.6	.49	42.0
n-Pentane	30.0	2164	36.8	.41	89.8
Hexane +	15.3	1530	16.7	.181	92.3
	248.3	14355	496.6		484.8

duty will now be determined. Assume for the moment, that no reheater will be used on this tower, and that the average stripping temperature is 390°. Steam consumption will be obtained by comparing the *K* of hexane at L.P. still stripping conditions with the *K* of hexane at the previously mentioned reference conditions (0.15 lb. steam per gallon lean oil at 350° and 50 psig.—see article 5). The L. P. still operates at 20 psig.

K of hexane at 390° and 20 psig. = 5.5
K of hexane at 350° and 50 psig. = 2.3
Ratio of *K*'s = 5.5/2.3 = 2.39

If the steam consumption were inversely proportional to *K*, the steam rate would be 0.15/2.39 = 0.0628. With an overhead of normal volatility, the actual rate would be somewhat less than this, perhaps 0.055. (See previous discussion on this point.) However, since the overhead is low in volatility, this figure should be substantially raised. For design, use a rate about 0.065 lbs. steam per gallon of lean oil.

The lean oil is 180 mol wt., 40° API (= 6.87 lbs./gal.), or gals./mol = 180/6.87 = 26.2. The total lean oil rate then is (286.4)(26.2) = 7500 gals./hr., and the steam rate is about (7500)(0.065) = 487 lbs./hr. Use 500 lbs./hr. process steam for design.

Assuming a reflux ratio of 1.5 (not including reflux necessary to condense steam internally), the reflux rate will be (1.5)(135.9) = 204 mols/hr. In order to determine the amount of steam condensed internally, the top tray temperature must be known. Because of doubt with respect to the composition of hexane +, however, this temperature cannot be computed, but must be assumed. Normally, with 50 psig. operation, the top tray will run at about 220°:

K of hexane at 220° and 50 psig. = 0.6
K of hexane at 178° and 20 psig. = 0.6

With a normal overhead vapor, the top temperature of this L.P. still would be about 178°. Since the overhead is considerably heavier than usual, use a top temperature of 190°.

Vapor pressure of water at 190° = 9.3 psia.
Total still pressure = 20 + 14.7 = 34.7 psia.

Assuming internal condensation of steam does occur, at the top tray the partial pressure of steam will be 9.3 psia., and that of hydrocarbons will be 34.7 − 9.3 = 25.4 psia. Consequently, for every mol of hydrocarbon vapor off the top tray, steam will be present amounting to 9.3/25.4 = 0.366 mol. With the reflux computed above, total hydrocarbons off the top tray will be 204 + 135.9 = 339.9 mols/hr., and steam overhead will be (0.366)(339.9) = 124.4 mols/hr. Process steam actually amounts to 500/18.02 = 27.7 mols/hr. Since the hydrocarbons are capable of carrying overhead 124.4 mols/hr. of steam, but only 27.7 are present, all process steam will go overhead to the L. P. still condenser. No internal condensation will occur, and no additional reflux need be provided to perform such condensation.

Note that according to the above results, no water drawoff tray need be provided. Actually, if there is any possibility that the L. P. still may operate at a much higher pressure, or that the rich oil may at any time contain a much smaller percentage of absorbed components, a drawoff tray should be included in the tower.

The L.P. still condenser will operate between 190° and 90°, and must totally condense the net overhead, reflux, and all process steam. The mol wt. of reflux and net overhead is found to be 71.2.

Latent heat of hydc. (190° to 90°, 71.2 mol. wt.) = 196 Btu./lb.
Latent heat of steam (190° to 90°) = 1084 Btu./lb.

(For convenience, steam at 190° has been assumed to be saturated.) Computing the condenser duty:

Condensing hydrocarbons:
(339.9) (71.2) (196) = 4,740,000 Btu./hr.
Condensing steam:
(500) (1084) = 540,000

L. P. Still condenser duty:
= 5,280,000 Btu./hr.

The temperature fall back of oil in the stripping section will now be determined in order to tell whether or not a reheater is required. This fallback is determined by a heat balance around the tower and condenser.

Heat entering the system consists of:

(1) Heat of cooling overhead as liquid from 400° to 90°.

(2) Heat of condensing steam from its condition when entering the tower until it leaves as water at 90°.

(3) The heat of cooling lean oil from 400° to the temperature (to be determined) at which it leaves the base.

Heat leaving the system consists only of the condenser load.

Process steam will be assumed to enter at 25 psig. saturated, (1170 Btu./lb.).

Heat In:
Cool overhead:
(135.9) (71.2) (364—144) = 2,130,000 Btu./hr.
Condense steam:
(500) (1170—58) = 560,000
2,690,000 Btu./hr.

Heat Out:
L. P. still condenser duty:
= 5,280,000 Btu./hr.

Heat removed from lean oil during temperature fallback in the stripping section = 5,280,000 − 2,690,000 = 2,590,000 Btu./hr.

Lean oil = (286.4)(180) = 51,500 lbs./hr.

With a specific heat of lean oil equal to about 0.6, temperature fallback of lean oil would be 2,590,000/(51,500)(0.6) or 84°. This is an excessive drop. so a reheater will be required. The reheater duty required to discharge lean oil at 400° will be 2,590,000 Btu./hr.

The amount of recompression horsepower required to compress surge tank vapors to the de-ethanizer column will now be determined. With the surge tank running at 90° and 145 psig. (5 psi. less than the H.P. still), surge tank vapors are obtained by an equilibrium calculation shown in Table 20.

With the de-ethanizer running at 450 psig., and allowing some pressure drops through valves, lines, and de-ethanizer preheater, recompression ratio will be about (465 + 14.7)/(140 + 14.7) or 3.1.

Mol wt. of vapor is 1247/34.9 = 35.7, for which "*n*" for compression is about 1.18.

Quantity of vapor in millions of standard cubic feet per day is 34.9/110 = 0.317 (110 mols./hr. = 1,000,000 SCFD).

From compressor charts,(2) brake horsepower per million CFD at the above ratio and "*n*" value is 66.5. Correcting for 90° suction (550° R), brake horsepower for recompression is:

(0.317)(66.5)(550)/520 = 22.3 BHP

A 25 BHP recompressor will be satisfactory.

It will be recalled that a 300 BHP recompressor was required in the sample calculation of the preceding articles of this series (refrigerated oil absorption). The still system's net overhead in that calculation was virtually identical to the overhead in this problem. Recovery rates were also substantially the same. But absorption oil distillation was performed in a conventional single still rather than in a two-stage system.

TABLE 20—Calculation of Surge Tank Vapors

	Total mols/hr. to Surge Tank	*K* at 145 psig. and 90°	Mols/hr. Surge Tank Vapors	Lbs/hr. Surge Tank Vapors
Methane	12.8	16.8	8.0	128
Ethane	45.2	3.1	10.7	322
Propane	115.5	1.05	11.0	485
iso-Butane	29.6	.48	1.4	81
n-Butane	93.1	.35	3.1	180
iso-Pentane	22.0	.144	0.3	22
n-Pentane	37.4	.113	0.4	29
Hexane +	28.6	.013	...	...
	384.2		34.9	1247

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Extract Sulfur from Sour Casinghead In Pressure Maintenance Plant

SULFUR IN COMMERCIAL QUANTITIES now is being obtained from sour casinghead gas in the Wyoming crude fields, at a new pressure maintenance plant operated by Stanolind Oil & Gas Co. The plant is located in the Elk Basin oil field on the Montana-Wyoming border about 18 miles north of Powell, Wyo. The sulfur recovery unit has a design rate of 74 tons/day and began initial operations in March.*

The product is recovered from the hydrogen sulfide removed from the field gas. The high concentration of H_2S—about 18.5 mol-%—is a favorable factor in the recovery of the sulfur. It is said to be the highest concentration encountered in any known gas production at the time of discovery of this Embar-Tensleep reservoir at Elk Basin.

Equipment for producing sulfur in the 12 million SCFD plant comprises a two-stage monoethanolamine process for sweetening the field gas and a recovery system based on a modification of the Claus process. Part of the acid gas from the amine unit is burned to sulfur dioxide, which in turn is reacted over bauxite catalyst with the balance of the hydrogen sulfide to produce sulfur and water. Variations of this process have been used, it is said, for a number of years in Europe, but only recently has it been commercially developed in this country.

Hydrogen Sulphide Removal

A flow diagram of the hydrogen sulfide removal system, the process design for which was developed by the Girdler Corp., is illustrated in Fig. 1. Because of the high acid gas (H_2S and CO_2) content, it was found desirable to use a two-stage amine process.

This system removes the acid gases from the raw, sour field gas by contact with a water solution of monoethanolamine in 21-tray contactors, or absorbers, installed at the discharge of the first (46 psig.) and second (152 psig.) stages of compression. The first-stage discharge gas is cooled, passed through a separator, and sent to the low pressure amine absorber, where it is partially stripped of hydrogen sulfide (content is reduced to approximately 100 grains/100 SCF) and almost completely stripped of carbon dioxide.

Second-stage discharge also is cooled, passed through a separator, and treated in the high pressure amine absorber for hydrogen sulfide removal to a maximum residual concentration of 0.25 grains/100 SCF, which will pass the lead acetate test. Sweet gas then is compressed in the third stage to 525 psig., cooled and charged to the main absorber.

The rich amine solution with its load of acid gas is pumped through heat exchangers to the re-activator where the H_2S and CO_2 are stripped from the solution by steam vapors generated in the reboilers. The reboilers are heated with extraction steam from the power plant.

For improved heat economy, a "split-flow" amine system is used. About half of the rich amine enters at the top of the packed re-activator and the remainder enters at the midpoint in the tower. A stream of partially stripped, or semi-lean solution, withdrawn immediately above the middle of the re-activator, exchanges heat with the feed, and is pumped through coolers to the low pressure absorber, entering the 15th tray from the bottom.

The completely stripped, or lean, solution from the bottom of the re-activator exchanges heat with the feed and is pumped through a cooler. From the cooler, this stream splits, half entering the high pressure absorber on the 19th tray and half entering the low pressure absorber on the 18th tray from the bottom.

Rich solution from the bottom of the high pressure absorber, having a relatively low acid gas content, is added with the semi-lean solution to the low pressure absorber. A water wash stream from the discharge of the re-activator reflux pump enters the top (21st) tray of the low pressure absorber, and a separate water wash stream, stripped of acid gas, enters the top (21st) tray of the high pressure absorber, thus minimizing amine loss to the gas streams. Splitting the flow of the rich and lean solution streams in this manner results in a reduction of heating and cooling loads on the re-activation system, the Stanolind engineers explained.

Overhead vapor from the re-activator is cooled to approximately 115° F.; the condensed water is pumped back to the tower as reflux, and the acid gas flows to the sulfur recovery unit.

Sulfur Recovery

At Elk Basin, acid gas from the amine unit, containing about 75% hydrogen sulfide and 25% carbon dioxide, enters the sulfur recovery

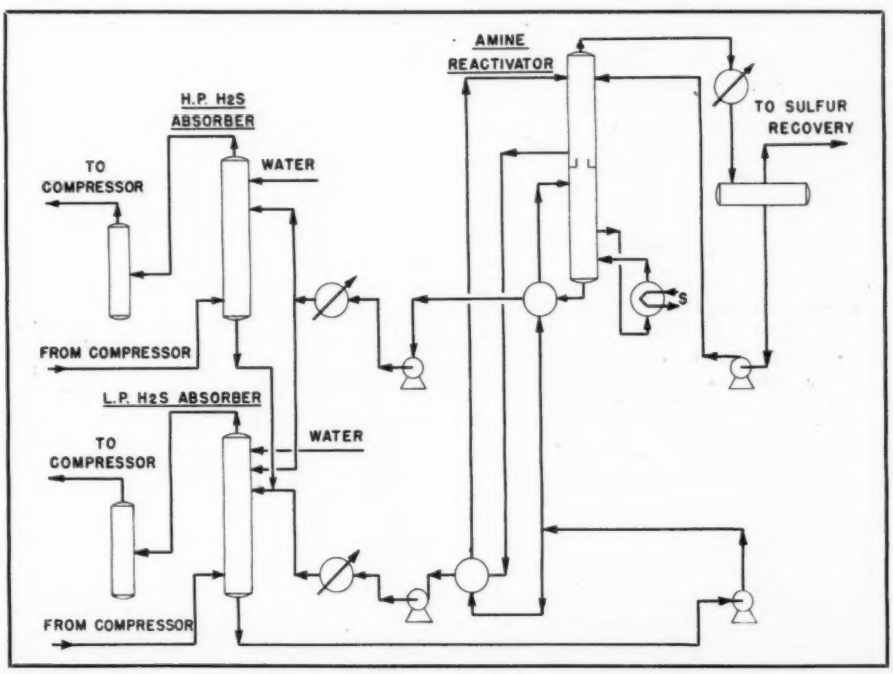

Fig. 1—Hydrogen sulfide removal system flow diagram for Elk Basin plant

* A description of the Elk Basin plant was presented at the American Petroleum Institute's Rocky Mt. Division meeting May 27 at Casper, Wyo., by L. R. Lyon, R. A. Feagan, Jr., and H. B. Manley, Stanolind Oil & Gas Co., in their paper: "Design Features of Plant in Elk Basin Oil Field—A Conservation Project." This article is based on the principal portions of that paper.

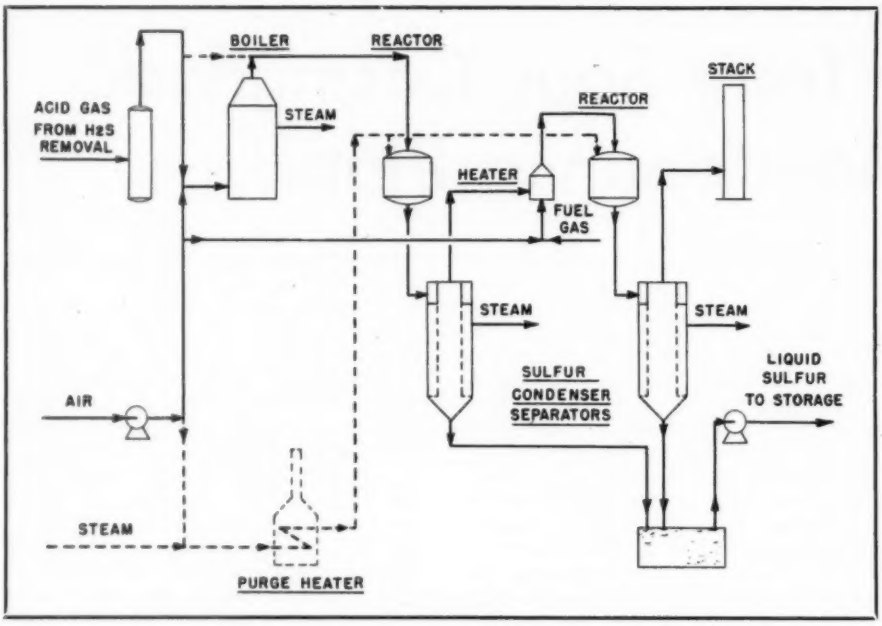

Fig. 2—Sulfur recovery system flow diagram at Elk Basin

unit through a scrubber which removes entrained water (Fig. 2). Part of the acid gas from the inlet scrubber is burned with controlled air in a specially-designed boiler to produce sulfur dioxide, utilizing the heat of combustion to generate 200 psig. saturated steam.

The combustion chamber of the boiler is operated at a pressure sufficiently high (about 3 psig.) to force the combustion products through the remainder of the process without blowers or compressors. Combustion products from the boiler, containing sulfur dioxide, are commingled with the unburned portion of the acid gas and pass to the first reactor, which contains a bauxite catalyst.

The design inlet temperature of the reactor is 450° F. Reduction of sulfur dioxide and oxidation of hydrogen sulfide occurs over the catalyst, releasing elemental sulfur. The heat of reaction raises the temperature to approximately 740° F., and at reactor exit conditions the sulfur is in the vapor state.

Sulfur Is Condensed

The reactor effluent gases are cooled to about 300° F. in a condenser-separator which condenses the sulfur vapor and generates low pressure steam at approximately 35 psig. Reaction is not completely effected in one reactor. Therefore, the remaining unreacted gases are reheated above the sulfur dewpoint to a temperature of 450° F. in a gas-fired, line-heater and pass to a second and final reactor where the reaction proceeds substantially to completion. The exit gas from the second reactor flows to a second condenser-separator where the sulfur vapor is condensed at about 300° F. The non-condensed gas, which should contain less than 1% hydrogen sulfide, is exhausted to the atmosphere.

Condensed liquid sulfur flows from the conical bottoms of both condenser-separators to a surge tank, and is pumped to storage through a steam-jacketed line.

A small auxiliary heater is provided to burn any potential accummulation of carbonaceous materials from the catalyst beds. This unit also serves as a start-up heater.

The important combustion reaction is:

$$H_2S + 3/2\ O_2 = H_2O + SO_2$$

The reaction over the catalyst is:

$$2H_2S + SO_2 = 2H_2O + 3\ S$$

The reactors are Lumnite-lined cylindrical vessels, about 16 ft. in diameter, with 6-ft. catalyst beds. Gas flow is downward through the 4 to 8-mesh bauxite catalyst, with a design space velocity of roughly 250 SCF/CF catalyst/hr. The catalyst bed is supported by a stainless steel grating and wire mesh. To minimize corrosion, an alloy of 18-8 stainless steel is used in the effluent piping from the reactors, and for lining the inlet channels of the condenser-separators.

Several methods were considered for the handling and storage of sulfur at Elk Basin. One of these was the use of a belt conveyor for atmospheric cooling and solidification, the sulfur being broken off in flakes at the end of the belt. The efficiency of such a technique is attractive for long-time operation, but the possibility of a market for liquid sulfur in the near future has resulted in selection of the simplest and least expensive method for initial operations, according to the Stanolind engineers.

Molten sulfur from the extraction unit is delivered through a steam-jacketed line to sulfur storage area. There, the sulfur is discharged into a temporary sheet-metal vat, where it solidifies by atmospheric cooling. The sheet-metal walls are raised as the sulfur hardens. When desired, the sheet metal is removed and the solid cake of sulfur is blasted, loaded into trucks, and hauled to a railroad siding at Powell, where conveyors are provided for intermittent loading into boxcars.

To date, the Elk Basin installation is believed to be the first known instance of a "sulfur-from-petroleum-hydrocarbons" plant being employed for recovery of the material from casinghead gas right out in the sour crude fields.

The efforts of the Pacific Coast petroleum industry to reduce "smog" in the Los Angeles area have resulted in a sulfur plant being constructed now for Hancock Chemical Co. at Los Angeles.(1) This company will use as a raw material the hydrogen sulfide or the hydrogen sulfide-rich amine solutions from the extraction units in the various oil refineries adjacent to the sulfur plant.

The plant, utilizing a modification of the Claus process also, is being built at a cost of about $1 million.

Two major refiners in the Los Angeles area have extracted hydrogen sulfide from cracker fuel gas for a number of years. In these cases the acid gas extract is piped to adjacent chemical plants for conversion to sulfuric acid.

New Plant on East Coast

More recently, The Texas Co. announced that hydrogen-sulfide-containing waste gases from its Eagle Point refinery at Westville, N. J., will be used in a new 40 ton/day sulfur recovery plant to be built there.(2)

The Elk Basin pressure maintenance plant is owned by 29 working interests who unitized the Embar-Tensleep reservoir and all lower potential horizons with the approval of the Secretary of the Interior in May, 1946. Stanolind Oil and Gas Co. is the operator. Construction of the plant was begun in September, 1947, and initial operations began in March, 1949. Stone and Webster Engineering Corp. was contractor for the job.

Handling 12 million SCFD of casinghead gas, the plant will produce propane, butane, natural gasoline, and sales gas in addition to the sulfur product. It also will manufacture 14 million SCFD boiler flue gas suitable for injection into the reservoir for pressure maintenance.

References

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The Use of Foam Fire Protection For Solvent Process Buildings

By C. L. JONES, Safety Engineer
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A permanent installation of so-called "protein base" foam, fire-extinguishing equipment was made by one chemical company as means of protecting processing equipment involving benzene, gasoline and furfural at operating conditions of about 100 psi. and 285° F. Selection of the foam apparatus was made after exhaustive tests of several extinguishing mediums, including water fog at 700 psi., chemical dry powder, water, carbon tetrachloride, inert gas, and a number of types of foam.

The raw materials—pine stump wood—and the finished products—resins, turpentine, and the like—differ considerably from those met with in a modern petroleum processing plant. However, the actual fire hazards involved and the kind of processing equipment employed are similar in most respects to many found in an oil refinery.

LOW-BOILING point solvents represent the chief fire hazard encountered during processing at the Brunswick, Ga., Naval Stores Plant of Hercules Powder Co. This plant processes pine stump wood and produces, by extraction of the milled wood, various pine products such as rosin, resins, pine oil, turpentine, etc. These products are further refined by solvents and used as raw materials for other chemicals.

The extraction process is carried out in pressure type extractors, constructed of steel and conforming to the ASME Code for Unfired Pressure Vessels. They are located in a building known as the Extractor House. The solvent is benzene, C_6H_6. The operating conditions for the vessels and other parts of the extraction system is of the order of 100 psi. at a temperature of about 285° F.

After the various pine products have been extracted from the milled wood, the hot crude, or drop solution, is processed in another building known as the Refinery. There the benzene is stripped off and returned to storage tanks near the Extractor House for further use as an extraction solvent.

The crude pine products, following separation from the benzene, are further processed in other buildings. One of these is the Pexite Plant, where various commercial grades of rosin, ranging up to "WW" are produced. The term "WW" refers to a clear or pale grade of rosin. Grades range from about "B" on up through the alphabet—the higher in the alphabet, the clearer and paler the rosin.

The solvents used in the Pexite building are gasoline and furfural. The quantity of solvents in process in each of the three buildings (Extractor House, Refinery and Pexite Plant) is large, the greatest amount being in the Extractor House.

The fire protection in place prior to the installation of the fixed foam protection described in this article consisted of deluge sprinkler systems in the Extractor House, Refinery and Pexite Plant, sprinkler systems of various types in all other buildings of importance on the plant, yard hydrants liberally placed, each being supplied with an adequate amount of 2½" C.R.L. (Cotton rubber-lined) hose, several portable foam generators with a liberal supply of foam powder, first-aid extinguishers of various sizes, such as 40-gal. foam engines, carbon dioxide, carbon tetrachloride, and dry powder chemical extinguishers of various sizes. Furthermore, the plant force had been trained in the use of all such facilities.

The water supply for the sprinkler systems is from a 100,000-gal. elevated water tank, providing an average static pressure of about 75 psi. at ground level. Fire pumps of several thousand gals. capacity per minute at about 100 pounds psi. supply the cast iron underground fire protection system, which feeds all of the various sprinkler systems throughout the plant, as well as the yard hydrants.

The fire protection cited above may seem adequate, but the company management believed the protection might not be effective in the event of a large spill of benzene or other solvent followed by fire, because water in any form (including "fog"), while useful in combating solvent fires, is not a completely satisfactory extinguishing medium for such fires.

A decision was made, therefore, to devise a system of protection which would be quickly effective on a fire involving benzene or other solvents which might occur in any one of the three main buildings; and that protection to be adequate to combat a fire involving all three floors of the Extractor House, having a total area in excess of 35,000 sq. ft.

A large amount of research work was carried out. Different fire fighting mediums were considered, and various size tests were made on fires involving burning areas up to about 1,000 sq. ft. per fire and 700 to 800 gals. of benzene. The fire extinguishing materials considered and tested were:

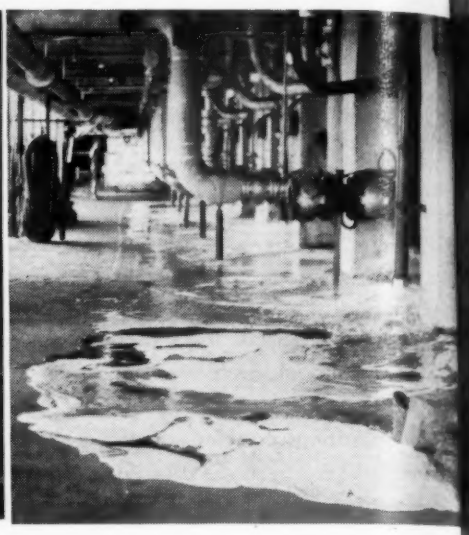
High pressure water fog up to 700 psi.; dry powder chemical; "wet" water; carbon tetrachloride; inert gas (CO_2); and fire foams of various kinds.

After completion of the various tests, which extended over a period of a year and a half, the observed results led to the conclusion that a protein base foam with an expansion of 9 to 10 was the best medium for combating and controlling benzene fires, and that such foam would also be effective on other solvent fires which might occur at the Brunswick plant. For example, in tests involving a surface area of 800 sq. ft. covered by 700 gals. of benzene, the fire was extinguished in less than three min-

MEET THE AUTHOR

C. L. Jones, a veteran of 37 years' service with Hercules Powder Co., and engaged in engineering work throughout that period, has devoted that last 20 years to accident and fire prevention in its various aspects. He has been concerned with problems relating to a great variety of chemical processes in use at the company's different plants.

A total of 30,000 gallons of foam is laid down within three minutes on the floor of the Extractor House. Series of pictures at right illustrate the rate of foam build-up over a portion of the lower floor. Elapsed time of 4½ minutes from left to right photographs indicates that foam blanketing is rapid and effective. Floor has been covered to a depth of six inches at the outer edge in the picture at far right



utes, and the foam blanket was so effective that it was not permeated by any appreciable quantity of benzene vapors. This was proved by failure to ignite when a large torch was passed over the top of the foam blanket.

Tests were also carried out to determine the effectiveness of a foam blanket on a fire involving hot benzene. It was found in these tests that even with the benzene at near its boiling temperature when fired, the foam blanket was effective in extinguishing the fire.

Use Solution Instead of Powder

A liquid foam solution instead of foam powder, or other foam producing mediums, was selected because of ease of operating the foam producing equipment and the simplicity of design. When using the liquid foam solution, one man, operating a few switches can quickly start up all of the equipment and arrange for the delivery of the foam solution to the desired points of use, where it is applied by fixed systems.

The design of protection finally adopted included fixed water-foam solution distribution systems, somewhat comparable to "sprinkler" installations, in each of the three buildings. In the case of the Extractor House, there is a total of six systems, each system being arranged to protect half of each of the three floors. Nearby is a building which houses pumps handling benzene; this pump house is similarly protected. Also, a number of large tanks near the Extractor House, which normally contain benzene, are similarly protected; that is, foam can be applied to the area around these tanks.

In each of the two other buildings a single system is installed. The complete protection system, including the protein-base foam material, was supplied by National Foam Systems, Inc.

It was reasoned that if fires should occur, those of greatest magnitude and severity would probably be at the floor or ground levels; therefore, the protection should be applied at these points rather than by spraying the foam through the air from nozzles or other outlets located high above the area needing protection.

The foam applicators as installed are placed so the discharge deflector plates are about 9 to 12 in. from the floor, or other surface protected. The piping distribution system which supplies the various foam makers is above head height with an air aspirator near the top of each foam maker.

The nozzles are so placed that in case of need all areas of all floors can be quickly covered with foam. The floor or ground of each protected area can be covered with a foam blanket at least 6 in. deep within three minutes or less.

The rate of foam application, about 1.20 gals./sq. ft./min., is in excess of the minimum requirements set by the Underwriters' Laboratories for the protection of tankage.

To supply the water-foam solution, the following equipment has been installed:

3—2200 GPM centrifugal water pumps, which deliver water at a pressure of 140 to 160 psi. (These and all other pumps installed on this project conform with the Underwriters' standards for fire pumps.)

Each of these pumps is driven by a 200 hp electric motor. In addition, two of these pumps are fitted with auxiliary drives, these being gasoline engines.

The water from all three pumps is delivered to a manifold, and from which individual underground steel pipe lines supply the fixed foam systems in the various buildings, each such line being manually valved off at the manifold.

To inject foam solution into the suction of the three 2200 gpm water pumps, two 400 gpm, 65 psi. centrifugal pumps are installed. The capacity of one of these two pumps is sufficient to supply the maximum quantity of foam solution required, and both are arranged to discharge foam solution into the suction line supplying water to the three 2200 gpm. pumps.

One of these solution pumps is driven by an electric motor, the other by a gasoline engine.

The desired water-foam solution is about 6%, although it has been found by test that the foam made from a solution which varies somewhat from this concentration is practical and effective.

Control Foam Proportioning

The proportioning of the foam solution is controlled by means of orifice plates which pass the required quantity of foam solution into the water suction line. For example: suppose one of the fixed systems calls for 600 gals. of water-foam solution. The foam-solution pump will deliver, through an orifice in the solution pipe line, 36 gpm of foam solution into the pump suction line, while 564 gals. of water per minute is discharged by the 2200 gpm. pump.

The 2200 gpm. water-solution pump will discharge the 600 gals. of water-foam solution to the system calling for that amount, because the requirements of the particular system will call for approximately that quantity of foam solution. The excess over the 600 gpm. demand is recirculated into the suction side of the water-solution pump by means of a relief valve.

The 600 gpm. of water-foam solution is delivered to the particular system needing foam. Near the top of each foam maker there is an air aspirator, which automatically mixes air with the solution, which is then delivered onto the burning surface.

To apply foam to any or all sections of the Extractor House, the operator manually starts up one or all

of the 2200 gpm. water pumps, and also one of the 400 gpm. foam solution pumps. The water-solution valve supplying a particular fixed foam system and the corresponding foam solution valve are then opened (all of which are permanently labeled); then the foam is automatically discharged from all of the marine nozzles or other applicator devices in that particular system.

A sufficient quantity of foam solution is provided to supply the maximum load for a considerable period of time. This foam solution is stored in a 10,000 gal. above-ground, steel tank, normally closed to the atmosphere. Both of the foam solution pumps have a flooded suction, and solution is always up to the pump suction. This tank is insulated to protect the contents from extremes of temperature.

The record indicates that the stability of the selected foam solution is exceptionally good; that is, there are records of such foam solution remaining sweet for many years, even under adverse storage conditions including rather high atmospheric temperatures in various parts of the world. The term "sweet" means there is no evidence of decomposition.

Water Supply of 400,000 Gals.

The quantity of water immediately available for supplying the 2200 gpm. pumps is approximately 400,000 gals. This water is stored in an above-ground steel tank located near the building housing the various pumps. The water flow (from wells) into this tank is of the order of 15,000 to 18,000 gpm. Furthermore, this tank is so placed that there is at all times a positive head of several feet on the suction of each of the 2200 gpm. water-solution pumps.

To augment the supply of water for the yard hydrants throughout the entire plant, and for all installed sprinkler systems, a cross-connection has been made from the discharge header of the three 2200 gpm. pumps to the underground fire system. Thus in case of need, a large added volume can be pumped into the underground fire protection system, providing a total pumping capacity of about 10,000 gpm., available for fire fighting purposes.

As the cast iron underground system is designed for a pressure of 100 psi., it has been necessary to limit the pressure of the water discharged into this system by the three 2200 gpm. pumps to that figure by automatic means.

First-aid Foam Also

In addition to the fixed protection, first-aid foam hose streams have been provided in the various buildings for combating small fires if any such should occur. There are 12 first-aid stations in the Extractor House, 4 in the Refinery, 4 in the Pexite Plant, and 4 in the yard area between the Extractor House and the Refinery.

This first-aid part of the foam protection is arranged as follows: Water and foam solution, always under pressure, is up to the respective quick opening valves at each first-aid station, so all that is necessary is for an operator to open these valves, and both water and foam solution are admitted in proper proportions to the first-aid hose, each of these hoses being fitted with a foam making nozzle.

A total of 100 ft. of 1½-in. hose, mounted on reels, has been installed at each first-aid station, and is permanently connected. The capacity of each such hose is 600 gpm. of foam.

To maintain pressure on the first-aid system, a small water pump is arranged to operate automatically. If the water demand from the first-aid stations should exceed the capacity of this pump, one of the 2200 gal. pumps is also arranged to operate automatically, starting up after a predetermined drop in pressure.

A similar method applies pressure to the foam solution; except, in this case, the automatically operated small foam solution pump is sufficient to supply the maximum number of first-aid foam hose stations which might be put into use.

In order to build up the required depth of foam blanket on the various floors, concrete curbs at least 6 in. high have been installed around the building perimeter on all floors. Similar curbs have been installed around all floor openings, so that each floor level or other surface protected is in effect a pan at least 6 in. deep. Thus, if a liquid spill should occur, it is retained within that pan, and when foam is applied, it builds up on top of that liquid surface. These curbs have also been placed around the protected tankage areas near the buildings.

All three foam protected buildings are also protected by sprinkler systems, and in case of fire, water could be discharging from many sprinkler heads. It was at first thought that this sprinkler water discharging onto the foam blanket would quickly damage it, and some consideration was given to the idea of shutting off the sprinkler systems. But, before reaching that decision, tests were made to determine if the foam blanket would be quickly damaged by sprinkler discharge.

It was found that the foam blanket was not seriously damaged by water flow from sprinkler heads for several minutes. Therefore, it was decided to leave the sprinkler systems "on" in all three buildings. The water discharge from the sprinkler heads serves to cool structural members and equipment, providing effective aid in combating the fire but without serious damage to the foam blanket on the floor.

Acknowledgment

Several persons assisted the writer in the preparation of the design of the fire protection facilities described. Of these, the following men deserve special thanks for their efforts and contributions: L. W. Boerner, chief engineer, National Foam Systems, Inc., West Chester, Penna.; C. B. Miller, vice president, Automatic Sprinkler Corp. of America, Youngstown, Ohio; H. N. Rider, manager, technical division, Automatic Sprinkler Corp. of America; and E. B. Rumble, manager, Fire-Fog Dept. of the same firm; J. A. McGarry, project engineer, Engineering Dept., Hercules Powder Co., Wilmington, Dela.; and M. S. Byers, general safety supervisor, Hercules Powder Co., Brunswick, Ga.

Broad List of Chemicals Is By-Product Of Fischer-Tropsch Gas Synthesis

A Staff Report by The Editors of PETROLEUM PROCESSING

THE QUALITY AND diversity of chemicals made from petroleum is due to be greatly increased when the first natural gas synthesis plant goes into operation some time next year. Some chemicals, at present commercially unavailable, will then be obtainable in sizable quantities. These, and other interesting facts, were discussed during the regional meeting of American Institute of Chemical Engineers in Tulsa May 9-11.

Data on the by-product chemicals from gas synthesis plants were presented by technologists of Stanolind Oil & Gas Co., which firm now is building a chemical purification plant at Brownsville, Texas, to separate and purify the water-soluble chemicals produced as by-products during operation of the adjacent Carthage Hydrocol, Inc., plant now under construction there. This plant will manufacture some 10,000 b/d of synthetic liquid hydrocarbons from natural gas, including gasoline and fuel oils, by a modification of the famous Fischer-Tropsch synthesis. The anticipated volume of water-soluble chemicals produced by the Stanolind plant exceeds 200,000,000 lbs. annually.

Processes Are Outlined

In a paper entitled "Chemicals From Hydrocarbon Synthesis," by T. Q. Eliot, S. C. Goddin, Jr., and B. S. Pace, all of Stanolind, a brief outline was presented of the processes which have been developed to separate and purify the water-soluble chemicals resulting from the natural gas synthesis operation and in the analysis of the many product streams. It also described the many difficulties encountered in securing pure chemicals from the extremely complex hydrocarbon mixture resulting from the synthesis.

Numerous authorities in the past have pointed out that a single "Hydrocarbon Synthesis Process" plant, producing 10,000 b/d of synthetic hydrocarbons, would also manufacture a long list of by-product chemicals, and asserted that volumes of certain chemicals would equal or exceed former total U. S. production. The Stanolind technologists concur, but point out that while the output of a 10,000 b/d plant is only 0.2% of the present U. S. crude oil production rate, volumes of chemicals produced range from less than 1% to 189% of U. S. production. Their comparison, using latest available data and hitherto unpublished estimates, is given in Table 1.

This indicates that, with the exception of propyl and amyl alcohols and organic acids with more than three carbon atoms, no individual synthetic chemical produced by one such plant will exceed 10% of previous U. S. output. The expected yields of n-propanol, propionic and butyric acids will, however, constitute significant additions to U. S. production. Table 2 shows the anticipated production in pounds per year of synthetic chemicals for every 1000 lbs. of synthetic hydrocarbons produced. It is interesting to note that certain of the minor-volume water-soluble chemicals, such as methyl-propyl-ketone and methyl-butyl-ketone, are not now commercially available. In this connection also, the Stanolind plant will not purify the oil-soluble chemicals pending further process development.

The typical yields in Table 2 are predicted from pilot plant data and are restricted to syntheses over fluidized iron (mill scale) catalyst at 550 to 650° F. and 400 psig. These oxygenated chemicals are distributed among the three product streams of the reactor—water, oil and gas. Oil and gas are scrubbed with water, producing a stream containing a majority of 1 to 5 carbon atom chemicals and an oil stream containing the higher molecular weight chemicals.

Separations Are Difficult

The water-solubles stream amounts to about 100,000 gal. per 1000 bbls. of oil and contains between 5 and 10 wt.-% chemicals. Simple fractionation produces a rich concentration of non-acidic chemicals and a dilute bottoms containing acids. Unfortunately, further distillation yields cuts which are principally azeotropic mixtures. Separations constitute a formidable problem, complicated by the tendency of certain components to oxidize, polymerize, or react with other constituents. The most difficult to process successfully are the aldehydes, which undergo all three reactions and require special precautions to prevent air oxidation in processing and storage to minimize corrosion problems and maintain product purity, the Stanolind authorities point out.

One of the major research problems, this paper states, has been that of developing techniques for analyzing the numerous chemical streams. This has been complicated because of the complexity of the mixtures, extreme ranges of concentrations involved and the high accuracies required, especially in detecting trace impurities. Stanolind's principal research emphasis has been on the refining of water-soluble chemicals in the past three years, preliminary to the design and construction of the commercial plant at Brownsville.

Corrosion-resistant materials are required in many parts of the equipment. Processing of hot organic acid streams preferably is carried out in stainless steel vessels. Hot processing of the non-acid chemicals normally is carried out in copper and copper alloy equipment to maintain satisfactory product purity and color.

According to these authorities, problems in refining oil soluble chemicals are of the same general nature

TABLE 1—Water-Soluble Chemical Yields from One 10,000 b/d Hydrocarbon Synthesis Plant, Compared with U.S. Production

Product	Year	U.S.(1)	HCS	Ratio HCS to U.S. yield
		Thousands of Lbs.		%
Methanol	1948	1,052,000(2)	600	<1
Ethanol	1948	1,100,000(3)	80,300	7.3
n-Propanol	1945	10,000	18,900	189
i-Propanol	1947	707,000	1,640	<1
Total butanols	1947	256,100	8,710	3.4
Total pentanols	1947	17,700	2,130	12.0
Acetaldehyde	1947	424,650	13,100	3.1
Propionaldehyde plus butyraldehyde	1948	100,000(4)	9,450	9.5
Acetone	1948	490,000	16,300	3.3
Methyl-ethyl-ketone	1945	70,000(4)	4,710	6.7
Acetic acid	1948	443,000	39,300	8.9
Propionic plus n-butyric acid	1948	20,000(4)	16,850	84

NOTES: (1) All figures are gross (from U. S. Tariff Commission reports)
(2) Includes natural methanol production
(3) Data from U. S. Bureau of Internal Revenue
(4) Estimated

as with water-solubles, but are intensified by the nature of the crude mixture. Whereas with water-solubles a rich chemical concentrate can be obtained by simple distillation, no such clean-cut separation is possible with oil-solubles. For example, when the boiling points of normal aliphatic acids, alcohols, aldehydes, ketones and paraffins are plotted vs. temperature, it will be noted that at any given temperature constituents of all species are found in close-boiling proximity. When it is considered that, in addition to the chemical and hydrocarbon types involved there also exist numerous isomers and azeotropes of chemicals with hydrocarbons, the separation of oil-solubles by simple distillation seems impossible.

Commercial Process Not Final

Numerous methods were proposed by the Germans to separate this mixture, employing caustic neutralization, esterifications and polymerizations plus azeotropic distillations and extractions, but only partial successes were achieved and complete separations were not made by any one process. Stanolind has been investigating the various possibilities for some time and improvements have been made over German technology, but the work has not progressed to the point where a commercial process has been developed in final form.

The Stanolind work has been greatly handicapped by the lack of fundamental data for many of the hydrocarbons and mixtures in both the water-soluble and oil soluble ranges. The present process for separating water-solubles relies heavily on azeotropic and extractive distillations and solvent extractions. Laboratory and pilot plant experimentation has been used to establish many of the possible separations in the lack of fundamental data for computations.

Natural Gas Oxychemicals

Another paper on oxygenated synthetic chemicals manufactured from natural gas was presented by M. F. Wirges and J. W. Palm, Cities Service Oil Co., Tallant, Okla., entitled "Production of Chemicals by Oxidation of Natural Gas Hydrocarbons." This is a general description of the process by which synthetic chemicals in significant quantities were first made from natural gas in this country. The process consists of two major divisions, synthesis and purification; the latter is not discussed in this paper.

Synthesis involves compressing the reaction gases, preheating them to the desired temperature, the reaction itself, cooling and condensing reactor effluent, separating product gas from unreacted gases, and treating product gas. The makeup gas may consist of any natural gas hydrocarbon in the C_1-C_4 range, or mixtures; the relative value of makeup gas determines the amount to be used. With higher molecular weight gases high conversions are necessary, utilizing principles of recycling and recovering any unreacted material from the product gas. With a methane-rich makeup gas, having low unit cost, complete conversions are not economically necessary and the tail gas may be utilized as fuel.

TABLE 2—Typical Chemical Yields per Daily 1000 bbls. of Hydrocarbon Production

Water-Soluble Chemicals	Lbs./year
Alcohols:	
Methanol	60,000
Ethanol	8,030,000
i-Propanol	164,000
n-Propanol	1,890,000
Butanols	871,000
Pentanols & higher	270,000
Total	11,285,000
Aldehydes:	
Acetaldehyde	1,310,000
Propionaldehyde	488,000
Butyraldehyde	457,000
Total	2,255,000
Ketones:	
Acetone	1,630,000
Methyl-ethyl-ketone	471,000
Methyl-propyl-ketone	194,000
Methyl-butyl-ketone	53,000
Total	2,348,000
Acids:	
Acetic	3,930,000
Propionic	1,030,000
Butyric	733,000
Valeric & higher	168,000
Total	5,861,000
Total water-solubles: 21,749,000	
Oil Soluble Chemicals:	
Alcohols	2,710,000
Aldehydes & ketones	2,780,000
Acids	2,740,000
Total	8,230,000

Either oxygen or oxygen-containing gases may be used as the oxidizing medium for making the synthetic chemicals, it was said. Until recently, oxygen has not been used because of its high cost. When air is used, for instance, it is necessary to provide a recycle system, or else remove chemicals and raw hydrocarbon gas from the tail gas stream. With pure oxygen, but little product gas must be vented because inert gases accumulate slowly.

The recycle, raw gas and air (or oxygen) may be preheated separately or in admixture. One or more of the separate streams may be sufficiently hot so that, upon mixing, the correct preheat is obtained. Almost any conventional method may be used to obtain preheat by exchange against product gas. Final product gas cooling may be by water-quench, which has the advantage of rapid cooling but wastes the sensible heat of the product gas so that preheating the reaction mixture by some other means must be provided.

The key to the oxidation process is in the reaction step. The most important considerations are short reaction time and provisions for dissipating the exothermic heat of reaction. Yields are controlled by several variables, the most important being pressure, temperature, makeup gas composition, recycle gas, catalysts and reaction time.

No special materials are required in reactor construction. Provision for control of process variables must be incorporated, however. After the reaction gases are cooled, the liquid product or quench solution is separated from the gas stream for chemicals recovery. The product is an aqueous solution containing substantial amounts of methanol, formaldehyde, acetaldehyde and acetone, with smaller amounts of acids and higher alcohols, aldehydes and ketones.

A portion of the product gas may be recycled to the reaction, the balance being withdrawn at a rate sufficient to maintain reactor pressure at the desired value. Unconverted hydrocarbons may be removed from the product gas by any of such conventional methods as absorption, chilling or adsorption and returned to the reaction via the makeup gas.

Process Variables

Yields, and quality up to a certain point, increase proportionately with increased pressure. Pressures above 400-500 psi. are more favorable to alcohols than aldehydes. For example, using a methane-rich makeup gas both at atmospheric pressure and 250 psi., the higher pressure will produce a 102% increase in formaldehyde yield, carbon converted to CO_2 will increase 56% and carbon converted to formaldehyde will increase 96%.

Preheat temperature is limited by the minimum at which the reaction will initiate or continue. Higher pressures and richer feed gases often will be accompanied by decreased preheat temperature. With a given preheat temperature, an increase in reaction temperature increases quantity of product but decreases concentration of chemicals in the product. The reaction may occur at temperatures of 800 to 1000° F; the preferred temperature, however, normally is in the range 840-890° F and varies inversely with makeup gas Btu., pressure and contact time.

Effects of Make-up Gas

A makeup gas containing larger amounts of higher molecular weight hydrocarbons will result in a higher chemical yield. However, the richer gases are the more valuable; hence with such gases containing considerable amounts of propane and higher, it usually is desirable to operate a hydrocarbon recovery system on the tail gas.

Makeup gas composition also affects the relative amounts of the various chemicals. The chemicals produced in largest amount with each of the lower molecular weight hydrocarbons are: methane—methanol; ethane—formaldehyde; propane and

TABLE 3—Product Streams from Stabilized Hydroformate

Product	Boiling Range, °F.	Aromatic Content, %
Light hydroformate	Pentane to 200° F	2–3
n-Heptane distillate	200–210	5–10
Toluene distillate	210–222	45–50
Toluene concentrate	222–235	60–65
Xylene distillate	235–300	55–65
C_9 aromatic distillate	300–450	98–99
Heavy aromatics	450° F & heavier	99

n-butane—acetaldehyde; and isobutane—acetone.

The effect of recycle in this operation may be illustrated by comparing formaldehyde yield with per cent makeup, where per cent makeup is defined as makeup rate times 100 divided by makeup rate plus recycle rate. When per cent makeup is decreased from 100% to 20%, yield per unit of makeup increases slowly. As makeup is further decreased toward zero the yield increases sharply. In this particular case the optimum recycle ratio might be in the range of 5% and 20% makeup, since in this range an appreciable yield per hour is obtained with a relatively small amount of makeup consumption. The exact value, however, depends on cost of makeup gas, value of the crude chemical products and plant capital costs.

Catalysts Used

Satisfactory yields may be obtained without catalysts. Among catalysts favoring the reaction are dehydration, dehydrogenation or oxidation catalysts; including platinum, chromium, manganese, copper, nickel, aluminum oxide and aluminum phosphate. Oxides of metals capable of forming higher and lower oxides, such as copper, manganese, iron, nickel, vanadium, chromium, and molybdenum, also have been used successfully. Careful selection is necessary in order to avoid carrying the reaction to completion—forming CO_2 and water.

Reaction time varies with conditions employed, being affected by temperature, pressure and catalyst. Time usually is in the range of 0.25 to 2 seconds. Too short a time gives incomplete conversion and excessively long times cause decomposition of alcohol and aldehyde products.

Aromatics by Hydroforming

Operation of what is still believed to be the largest commercial hydroforming unit in the world to produce high quality gasoline blending stocks, solvents and chemical intermediates, and the war-time operation of this unit to manufacture nitration grade toluene, aromatic solvents and aviation gasoline blending stocks was described by C. H. Marshall, Humble Oil & Refining Co., Houston, under the title "Production of Aromatics." The process is stated to offer a number of advantages over the older thermal reforming process for upgrading quality of low-octane number virgin naphthas. The chemical intermediates referred to above include 98-99% pure toluene, mixed xylenes of 98-99% aromaticity, a 95% pure C_9 fraction and a 90% C_{10} aromatic fraction.

Although the production of high purity toluene and xylenes for solvents requires the use of some kind of precise extraction process, any refiner having a combination of hydroforming and distillation equipment may utilize them to recover from the hydroformate components suitable for high quality motor or aviation gasoline, this authority states. It is possible to segregate a toluene concentrate normally containing 60-65% toluene, an excellent blend stock for aviation gasoline. The 200° F. end point light hydroformate also contains appreciable isohexane and isoheptane fractions which may be recovered for use as avgas blending stocks.

In addition to effecting greater octane quality improvement for a given gasoline yield than thermal processes, hydroforming produces a very stable, low-sulfur gasoline, usually doctor sweet. Little or no finishing treatment is necessary. Stability both to color degradation and gum formation is achieved because of the negligible concentrations of olefins and particularly diolefins in the hydroformate. Flexibility exists in adjusting octane quality to the desired level over a considerable range while obtaining optimum balance between yield and octane improvement.

Feedstocks

Feed stocks having the highest percentage of suitable naphthenic compounds produce hydroformates with the highest octane number. In general Gulf Coast naphthas have a considerably higher naphthenic content than Mid-continent stocks, and still more than East and West Texas stocks. The fraction boiling from 250° to 400° F. is the most desirable feed where hydroformer capacity is limited by factors other than feed stock availability. A 350-end point feed is used where premium gasoline only is being made which has a sharply limited backend volatility. The fraction boiling from 200° to 250° F, containing methylcyclohexane, offers a good but lesser opportunity for octane improvement, A heavy naphtha, 400-450° F., may be included if capacity is available because it may be severely reformed to material boiling below 400° F. end point.

Postwar operation of the big plant, which Humble bought from the government, involves the processing of 400° F. end point crude naphthas. This stock is charged to the crude naphtha unit, consisting of three towers, wherein a butane-to-200° F. light blend naphtha is produced from the first 50-plate superfractionator and subsequently stabilized in a 30-tray tower for complete butane removal. This stock is further processed to recover i-pentane, i-hexane and i-heptane fractions for avgas blending agents.

The 200-400° F. bottoms from the first tower are cut to end point to produce overhead the desired hydroformer feed. The type of naphtha charged determines boiling range of hydroformer feed. Normally a 200-300° F. fraction is segregated to produce toluene, xylenes and a C_9 aromatic fraction, but when highly coastal-type naphthas are processed the end point is 345°-350° F. to include C_{10} naphthenes to produce a C_{10} aromatic fraction.

Non-Aromatics Excluded

In producing C_9 and C_{10} aromatics, inclusion of naphthenes resulting in aromatics boiling in the desired distillation range is imperative to produce specified aromatic purities. Choice of the feed cut point also must be made to exclude essentially all non-aromatic material boiling in the range of the desired product which will dilute purities below the specified minimum. For example, maintaining hydroformer feed end point at 295° F. for C_9 aromatics permits inclusions of principally trimethylcyclohexanes which, after hydroforming, will yield aromatics boiling in the desired range of 300°-350° F. Processing a higher end point feed, including such C_9 naphthenes as methylethylcyclohexanes and propyl cyclohexane (boiling range 305°-315° F.), will dilute the aromatic distillate below specified aromatic purity. Recovery of solvent products from stabilized hydroformate for subsequent finishing is done on a series of distillation towers known as the Intermediate Rerun Unit. Major products from this unit are given in Table 3.

Finishing Steps

The finishing steps applied to obtain toluene and xylenes from the distillates containing them follow much the same pattern as was used in wartime operation; sulfur dioxide extraction followed by acid treating and re-running to obtain a heart-cut color-stable product. Processing of the higher molecular weight C_9 aromatic distillate involves only treatment with 98% sulfuric acid and redistillation to insure good color stability of the finished product. Production of the finished C_{10} aromatic fraction is the same as for the C_9 aromatic.

AIChE MEETING

Process Cost Studies Are Presented In Papers on Refining Economics

A Staff Report by the Editors of PETROLEUM PROCESSING

COST-CONSCIOUS petroleum processing technologists gathered in Tulsa May 8-12 for a southwestern and predominantly oil-industry meeting of the American Institute of Chemical Engineers. They centered much of their attention on papers and discussions concerned with the economics of several refinery processes in current use.

Among processes covered in two sessions devoted to chemical engineering economics were:

1. Alkylation and polymerization as profitable means for producing from C_3 and C_4 olefins, motor fuels of today's requirements in octane level.
2. Thermal reforming as an economic road to the desired octanes under present price structures.
3. Favorable use of Hypersorption for obtaining high propane recovery in a natural gasoline plant operating in the intermediate pressure range.

Although no overall "magic" formula can be had by which an individual refiner can determine the advantages or disadvantages of one process over another, a common approach to such problems was seen in each of the technical papers dealing with process economics.

That common approach—or common denominator—is the application of the dollar sign to such usual "at-the-refinery" data as raw materials costs, products prices, operating and maintenance manpower, repair parts and inventories, optimum processing rates and yields, utility requirements, original investment, amortization, and reasonable "pay-out."

In the larger sense, the refiner must of course also consider other factors outside the immediate sphere of any particular process. As emphasized by a number of chemical engineers at the Tulsa meeting, these factors would certainly include present and future market conditions for the product, demand trends for other products perhaps from the same cut in the barrel of crude oil, the labor union situation, plant layout, storage facilities, handling and shipping procedures, and safety and fire protection requirements.

In addition to the sessions on economics, the AIChE meeting total of 27 technical papers covered such topics as chemicals from petroleum, primary energy, and oil and gas production. A PETROLEUM PROCESSING staff report of the session on "Chemicals from Petroleum" appears in this issue on page 676. Review of four papers on economics follow.

Alkylation and Polymerization

"Economics of Alkylation and Polymerization" by R. E. Sutherland and J. L. Doegey, Universal Oil Products Co., Chicago, Ill.

REFINERS TODAY are vitally interested in profitable means for obtaining higher octane numbers. For this reason, the authors point out, there is a valid reason for reviewing the economics of two processes for producing high grade gasoline, one of which was so highly successful in making wartime aviation gasoline.

A series of cost studies based upon extensive pilot plant studies of alkylation and polymerization led to the following conclusions:

1. Production of motor fuel from C_3 and C_4 olefins by either alkylation or polymerization is a profitable operation. This fact tends to increase the cost of these olefins as raw materials for other uses.
2. Supplies of normal and iso-butane must be plentiful at some margin below the gasoline level if alkylation is to be profitable.
3. At olefin capacities above approximately 500 b/sd, and with casinghead available at a reasonable price level, alkylation becomes more profitable than polymerization.
4. At low olefin charge rates, alkylation may be more profitable than polymerization, as is shown in the illustrative cases in the paper. But the factors of relatively high operating and plant costs must be considered since, in general, regardless of the higher profits possible, high fixed charges are not desirable.
5. In order to be competitive with HF, alkylation, sulfuric acid alkylation requires that the cost of the acid be charged against more than one process in the refinery because of the high acid consumption rate.

It was found in the cost studies that there is a definite advantage of alkylation over polymerization, and vice versa, depending on conditions in each refinery; for example:

1. Quantity and type of olefins.
2. Availability and cost of light hydrocarbons for vapor pressure requirements.
3. Availability of iso-butane.
4. Quality of product demanded in each particular market.

As for the two types of alkylation units, it was said that the quality and yield of product from butylenes are about equal. The HF method is cheaper on the basis of initial cost. It operates at normal cooling water temperatures, whereas sulfuric acid alkylation requires extra refrigeration equipment to remove the heat of reaction at 35-40° F.

Acid regeneration for the HF method is simple, inexpensive, and an integral part of the processing unit. For sulfuric acid, such equipment is expensive to build and operate, and it usually is installed only where large quantities of acid are processed. This fact limits its use to

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TABLE 1—Comparison of Two Feedstocks—Mol-%

	Cases 1 & 2	Cases 3, 4, & 5
Constituent	C_3+C_4	C_4 only
Propylene	22	..
Propane	20	1
Butylenes	25	46
iso-Butane	22	35
normal-Butane	11	17
C_4's	..	1

some extent to refineries having other uses for sulfuric acid. However, the difference in initial and operating costs is not too great, and these are affected by the cost of the chemicals.

HF catalyst requirements, fairly high during the initial operation of the first commercial units, have gradually been reduced to a very low level. A figure of 0.5 lbs. of HF per bbl. of alkylate was used in the UOP work. In fact, one of the units had an average consumption of 0.25 lbs. of HF per bbl. for two years of continuous operation. The cost ranges from 4.5 to 9.0c/bbl. of alkylate.

Sulfuric acid requirements range between 0.5 and 0.8 lbs. acid per gal. of alkylate. On this basis, sulfuric to compete with HF can be a maximum of 0.43c/lb., and in the best case must be as low as 0.21c/lb. The present market on sulfuric is about $15 per ton (0.75c. per lb.); it is therefore necessary to regenerate sulfuric acid or divide its cost with other uses in the plant.

HF units in general are more flexible because both C_3 and C_4 olefins can be processed less expensively than with sulfuric acid.

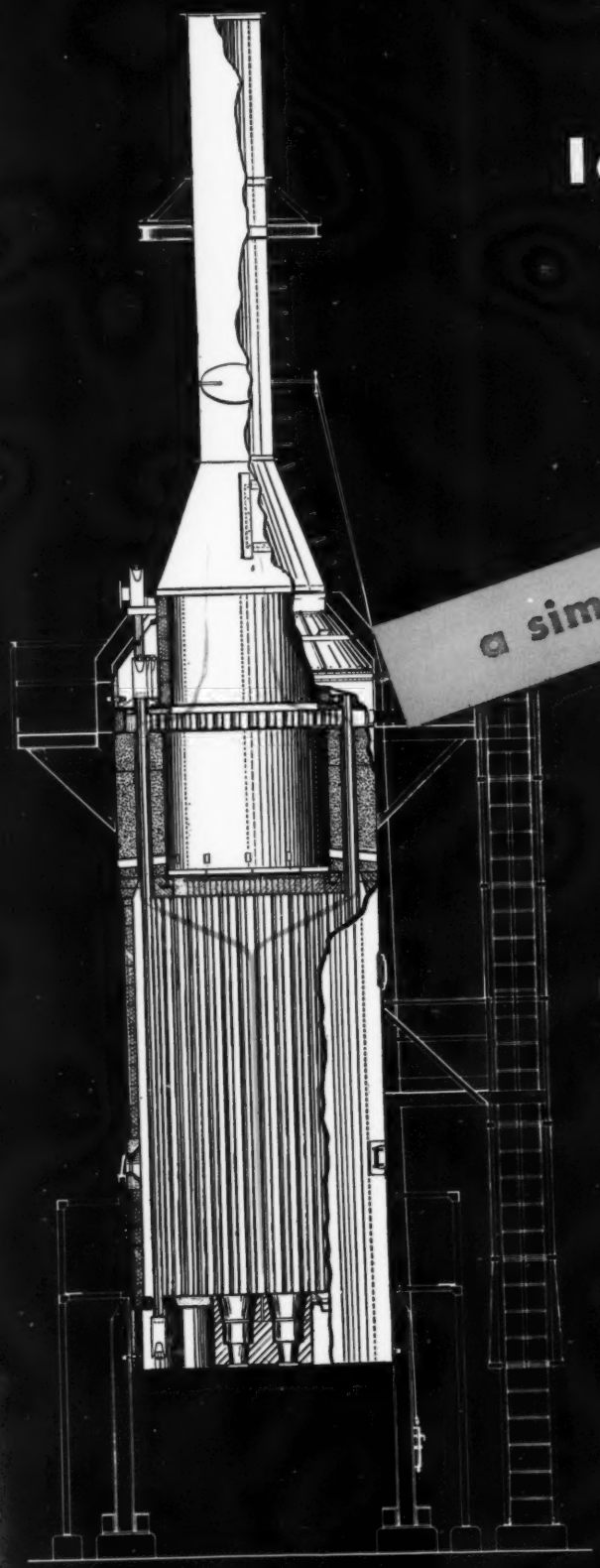
As a basis for the economic comparison of the several methods, the authors used the following factors:

1. Plant investment costs,
2. Direct operating costs,
3. Overall octane levels possible,
4. Butane balance,
5. Total gasoline production.

The rather broad uses which have been developed for butylenes make it necessary that the possibility of economical use in these other fields be explored and compared with their value as a high grade motor fuel component. It is assumed that the C_3 and C_4 olefins are in excess in the refinery and valued as low cost fuel gas.

The most pertinent results of the cost studies are shown in the tables, several of which represent consolidation of data presented at the Tulsa meeting.

Table 1 compares the two types of feedstock used; one a C_3+C_4 material, the other C_4 only. Table 2 gives a comparison of yields, plant and operating costs, and octane number costs for the two feeds. They were run in both a reactor type poly plant and a chamber type poly plant in the case of the C_4 only material. Figures were given in the original



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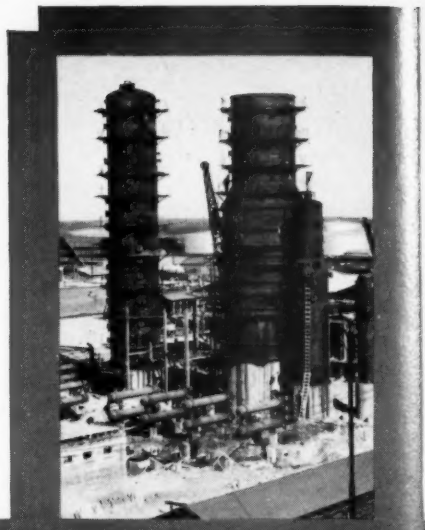

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TABLE 2—Yields, Plant and Operating Costs, and Octane Quality

Operation	Case 1 Reactor Poly		Case 2 HF Alkylation		Case 3 Chamber Poly		Case 4 Reactor Poly		Case 5 HF Alkylation	
Feedstock	C_3—C_4		C_3—C_4		C_4		C_4		C_4	
Olefins, b/sd.	1000	2000	1000	2000	1000	2000	1000	2000	1000	2000
True polymer, b/sd.	695	1390	....	....	735	1470	735	1470	....	....
True alkylate, b/sd.	....	....	1740	3480	....	....	....	....	1700	3400
Outside i-but. b/sd.	....	....	800	1600	....	....	....	....	360	720
Residual C_4 Balance:										
Res. butylenes	57	....	....	....	100	....	100	....	....	....
Res. i-butane	570	....	....	....	840	....	840	....	....	....
Res. n-butane	270	....	397(a)	....	386	....	386	....	513(a)	....
Total Residual C_4	897	....	397	....	1326	....	1326	....	513	....
Debutanized Product	695	....	1740	....	735	....	735	....	1700	....
Overall RVP, including product	39	....	12	....	45	....	45	....	15	....
Plant Cost:										
$/bbl. Olefins	540	445	1850	1150	460	380	485	400	1600	1000
$/bbl. Products	775	640	1060	660	625	515	660	545	940	590
Operating Cost:										
c/gal. Olefins	1.00	0.92	3.48	2.83	1.15	1.08	0.96	0.87	3.00	2.40
c/gal. Products	1.44	1.32	2.00	1.63	1.56	1.47	1.31	1.18	1.77	1.41
Octane No. of Prod.:										
F-2, Clear	82.5-83		91+		82.5-84		....		93.5+	
+ 3 cc. TEL.	84-84.5		98+		85		....		100+	
F-1, Clear	96-97		92-93		96-97		....		94-94.5	
+ 3 cc. TEL.	99-100		98+		100		....		100+	
1000's of F-1 Oct. bbls.:										
Clear	....	133	....	320	....	141	....	....	....	320
+ 3 cc. TEL.	....	137	....	341	....	147	....	....	....	340
Operating Costs, c per Octane bbl:										
F-1 Clear	....	0.58	....	0.74	....	0.64	....	....	....	0.63
+ 3 cc. TEL.	....	0.56	....	0.70	....	0.62	....	....	....	0.59

(a) Including 127 b/sd. of normal butane as a side reaction.

paper for three different size runs, 500, 1000, and 2000 b/sd. It was shown that at high capacities, the alkylation unit capital and operating costs, on the basis of product, are practically the same as for polymerization.

It also can be seen in this table that outside normal and iso-butane are needed in alkylation for vapor pressure requirements. This factor is of considerable economic importance, because in those cases where alkylation is profitable, normal and iso-butanes are available in casinghead, which normally can be profitably purchased for blending and vapor pressure control. Polymerization, on the other hand, has sufficient residual butane so that little or no casinghead may be used.

The effect of operating costs on octane quality also is shown in Table 2. Here, the polymerization technique has a slight edge over alkylation on the motor method (F-2), while they are about equal on research (F-1). On road tests, polymer is better at low speeds and not as good as alkylate at high speeds.

Typical comparative economics of polymerization and alkylation are presented in Table 3.

TABLE 3—Comparative Economics of Polymerization vs. Alkylation

Operation	Reactor Poly.		Alkylation	
Feedstock	C_3—C_4		C_3—C_4	
Olefins, b/sd.	500	1000	500	1000
Outside iso-but., b/sd.	...	....	400	800
Debutanized Prod. b/sd.	347	695	870	1740
Charges, $/sd.:				
Feed @ 8c/MM Btu.	148.30	296.60	260.00	520.00
Direct Operating	254.00	420.00	955.00	1460.00
Out. i-but. @ 4½c/gal.	.....	.....	756.00	1512.00
	402.30	716.60	1971.00	3492.00
Amortiz. @ 10%/yr.	100.00	164.00	457.00	563.00
	502.30	880.60	2428.00	4055.00
Overall, c/gal. prod.	3.45	3.01	6.65	5.55
Credits, $/sd.:				
Assuming prem. gasoline @ 10c/gal.	1460.00	2920.00	3655.00	7300.00
Net profit after amort., $/sd.	957.70	2039.40	1227.00	3245.00
Differential profit	.....	.....	269.30	1205.60
Investment required	$330,000	$540,000	$1,500,000	$1,850,000
Pay-out in Years	0.95	0.75	2.72	1.48

Hypersorption for Propane Recovery

"Optimum Propane Recovery in Natural Gasoline Plants," by Ben M. Holt, The Ralph M. Parsons Co., Los Angeles, Calif.

THE recently developed Hypersorption process—extraction by *ad*sorption on activated carbon—was studied in economic comparison to a conventional oil *ab*sorption method for obtaining optimum propane recovery in a natural gasoline plant.

Hypersorption was shown to have an economic advantage in a cost study based on the following conditions: 20,000,000 CF/day of sweet, wet field gas available at 35 psig.; propane and heavier to be extracted; dry gas to be delivered to a pipe line at 150 psig.; and no limitations placed on the heating value of the dry gas.

An investment of $1,590,000 is involved for a plant employing the Hypersorption process and recovering 98% propane. The conventional, high-pressure type oil absorption plant represents an investment of $1,910,000 and has a recovery of 80% propane. The analysis of the field gas used in each case is shown in Table 1, first column at left.

Flow in the Hypersorption plant is as follows. First stage compression raises incoming gas to 170 psig. It then is cooled to 45° F. by interchange with absorber tail gas and by propane refrigeration, and passes to the absorber, operating at 160 psig. Because of the low temperature and the fact that most of the gasoline already is condensed, the absorption oil requirements to remove petanes in the tail gas are quite low, on the order of 25 gpm. Also, at this temperature, a heavy gasoline cut serves as the absorption oil. The refrigeration duty is a 150 hp. propane compressor.

Gasoline and most of the pentanes are removed ahead of the Hypersorber because Hypersorption stripping of the gasoline range hydrocarbons from the high activity carbon

TABLE 1—Material Balance (mols/hr.) Hypersorption vs. High Pressure Absorption

	Feed		Tail Gas		16#RVP. Gasol.		Butane		Propane	
	Mol-%	Mol./hr	Hyp.	Ab.	Hyp.	Ab.	Hyp.	Ab.	Hyp.	Ab.
Methane	83.3	1831.4	1831.4	1831.4	....	....	....	....	....	....
Ethane	8.0	176.0	1.4.5	174.5	....	....	....	....	1.5	1.5
Propane	4.0	88.0	2.0	18.0	....	....	0.9	0.9	85.1	60.1
I-But.	0.7	15.4	....	0.1	1.9	3.8	12.3	10.5	1.2	1.0
N-But.	1.3	28.6	....	0.2	10.6	7.1	16.8	20.3	1.2	1.0
I-Pent.	0.7	15.4	....	....	14.4	14.9	1.0	0.5	....	....
N-Pent.	0.5	11.0	....	....	10.9	10.9	0.1	0.1	....	....
Hex.-	1.5	33.0	....	....	33.0	33.0	....	....	....	....
Totals	100.0	2198.8	2007.9	2024.2	70.8	69.7	31.1	32.3	89.0	72.6
MSCFD	....	20,000	18,264	18,412	....	....	....	....	....	....
Gals/day	....	....	....	....	25,600	25,500	9000	9350	22,000	17,950

	Hyp.	Ab.
Total Liquid Products, g/d.	56,600	52,700
Shrinkage, MSCFD	1736	1588

TABLE 2—Estimate of Manufacturing Costs

	Hyper.	Absorp.
Investment:		
Hypersorber, incl. initial chge carbon	$640,000	.....
Other facilities, incl. compressors	950,000	.....
Totals	$1,590,000	$1,910,000
Manufacturing Costs (350 operating days/yr.) in $/day:		
Utilities: Fuel gas at 10c/Mcf.	110	190
Electricity at 1c/KW	20	40
Operating labor: 3 men/shift at $2/hr.	144	144
Superintendence, office, etc.	34	34
Maint. at 3%/yr. on plant investment	136	164
Taxes, Insur., overhead at 5% on investment	228	273
Shrinkage at 10c/Mcf.	173	159
Royalty (approx.)	46	...
Carbon make-up(1)	28	...
Amortization (5 years)	910	1090
Totals	$1829	$2094
Cost of Liquid recovered, c/gal.	3.22	3.97

(1) Make-up based on average for 5 years. Usually higher during first year.

used in the unit has been found very difficult.

Returning to the flow description, the absorber rich oil next is preheated against lean oil (gasoline fractionator bottoms) and flows to the stabilizer. The stabilizer overhead joins the main feed stream to the Hypersorber. Stabilizer bottoms are fractionated into a light and a heavy gasoline. Part of the heavy gasoline is recirculated as absorption oil while the remainder joins the light gasoline in storage. The use of sharply fractionated absorption oil minimizes contamination of the feed stream to the Hypersorber, it is said.

The Hypersorber measures 6 ft. 6 in. in diameter, is 140 ft. in overall height, and operates at 150 psig. It has a double feed inlet to two separate adsorption sections, one above the other. Fresh carbon goes to each section. Carbon is stripped by heating with Dowtherm vapor in tubes in the bottom of the unit. The carbon rate is 30 tons/hr. Carbon is returned to the top of the tower by a gas lift system designed by Union Oil and involving a number of design equipment features not as yet available in complete description form.

The tail gas from the unit goes to the pipe line. The bottoms pass on to conventional columns for separation into propane and butane. The author stated that the absorption unit serving as the feed preparation equipment for the Hypersorber costs roughly 20% less than a conventional oil absorption plant alone.

The high-pressure absorption plant generally is of conventional design. First two stages of compression boost the feed gas to about 460 psig. The pertinent features of the plant are:

1. Lean oil and incoming gas are cooled to within 5° F. of the cooling water temperature. Refrigeration does not appear to be justified.

2. Recycle of cold flash vapors, demethanizer and de-ethanizer overhead streams, to the primary absorber is utilized to give good payout in terms of higher propane recovery.

3. Increasing propane recovery beyond an overall of 80% brings about substantial increases in the oil rates and recycle streams, and does not appear to be justified.

The material balance for the two processes is compared in Table 1. A comparison estimate of costs is shown in Table 2.

Thermal Reforming Economics

"Economics of Thermal Reforming," by C. F. Feuchter, Pan American Refining Corp., New York, N. Y.

MANY REFINERS obtain increased octane numbers in straight-run naphthas by the use of thermal reforming. While this process improves gasoline quality, it also lowers the yield of salable liquid product. The optimum reforming level must be determined by an economic balance between the cost of tetraethyl lead required to reach specification octane levels and the loss in yields sustained by thermal reforming.

A method for computing optimum reforming level is demonstrated for a hypothetical refinery, in which both the severity and the boiling range of the straight-run naphtha being reformed are varied until that point is reached where the cost of meeting octane specifications is at a minimum. The following conclusions were indicated for the hypothetical refinery, processing 20,000 b/d of East Texas crude:

1. With a price structure approximating present-day conditions, the maximum profits by thermal reforming are obtained when charging 3,000 b/d of heavy naphtha, equivalent to a 275-400° F. boiling range, and operating at a reforming severity equivalent to an octane number increase in the reformate of about 14.0. However, even at optimum reforming conditions, the savings are comparatively small, about 1c/bbl. of total gasoline.

2. The octane number specification has a relatively large effect on the economics of thermal reforming. At the higher octane levels, it is necessary to thermally reform in order not to exceed the maximum legal allowable TEL content of 3 cc./gal.

3. A decrease in gasoline price increases the attractiveness of thermal reforming. At a low gasoline price it is possible to operate over a relatively wide range of reforming severities and still be near the optimum; whereas, with a high gasoline price, a small variation in reforming severity results in a large drop in profits.

4. Thermal reforming is considerably more attractive when the price of butane is high than when it is low. Inasmuch as the butane price is usually higher in winter than in summer, and since thermal reforming is employed for increasing gasoline volatility it is apparent that thermal reforming is more advantageous economically during the colder weather seasons.

5. The economics of thermal reforming and the optimum reforming level will vary for the individual refinery, depending upon the type of crude being processed and the type of equipment being employed. Con-

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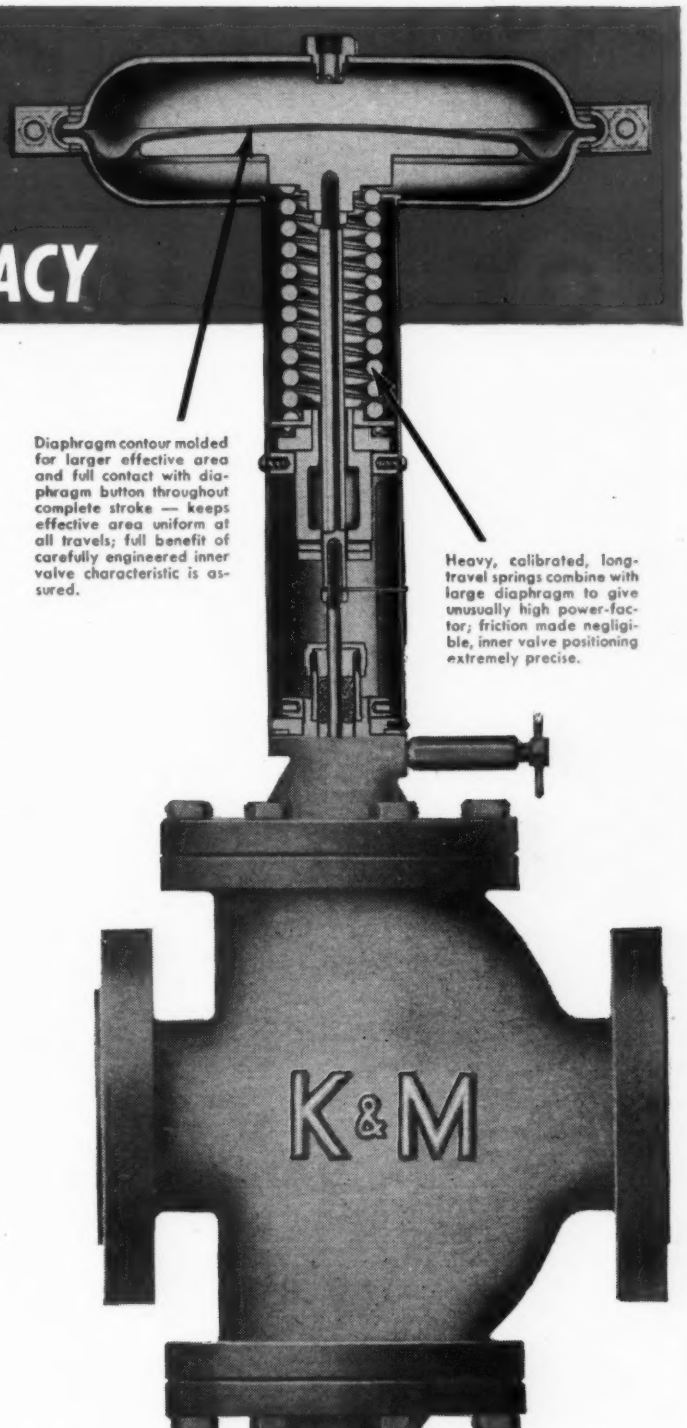

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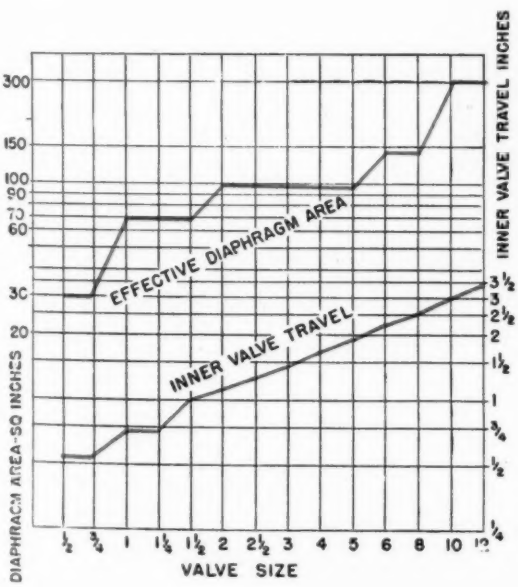

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sequently, the thermal reforming correlations used in determining the optimum reforming level for the hypothetical refinery have been included in the study in order to permit a refiner to determine the economics in his own situation.

The hypothetical plant used in the cost study contains a crude distillation unit, a visbreaker, gas oil cracker, catalytic polymerization, thermal reformer, and a vapor recovery system. The thermal reforming unit has sufficient capacity to charge any desired quantity of virgin heavy naphtha at an average reforming pressure of 600 psi. The catalytic polymerization unit is large enough to polymerize the propylene produced, together with a sufficient quantity of butylenes to reduce the Reid vapor pressure of total gasoline production to 10 lbs. Kerosene and No. 2 fuel oil yields of 10 and 15% respectively on crude are assumed.

No particular mention is made of other processes, such as hydroforming and gas reversion, that are widely used for increasing octane number. In both types of operation, investment and operating costs are slightly higher than for thermal reforming it was said. Also, it is possible to reform thermally to a slightly higher octane number.

The optimum reforming level is determined by an economic balance between the cost of tetraethyl lead required to reach octane level specification and the loss in yields sustained by thermal reforming. The optimum is that severity where the sum of the TEL cost, the decrease in value of products, and the operating cost of the thermal reforming unit is at a minimum. The author readily pointed out that the current trend toward a continued drop in the lead market will have a marked effect on conclusions he had reached a few months ago.

For example: his study was based on a price value for the anti-knock compound of 0.215c/cc. The price for motor mix lead compound on April 6 was 0.21c/cc., and had dropped still further on May 10, to 0.2073. Other items in the price structure employed were: gasoline, 9.5c/gal.; butane, 7.5c/gal.; Bunker C, $1.35/bbl.; and gas (fuel oil equivalent), $0.425/bbl.

The estimated yields and gasoline quality from the hypothetical refinery when using no reforming are given in Table 1. With no reforming it would be possible to blend an additional 170 b/d of butane into the gasoline production without exceeding 10 lbs. RVP. With the low price usually met for butane, it usually is profitable for the refiner to produce gasoline at the maximum allowable RVP by buying butane.

Since the Research octane number seems to correlate better with actual road performance, the Research method was used in the paper. It

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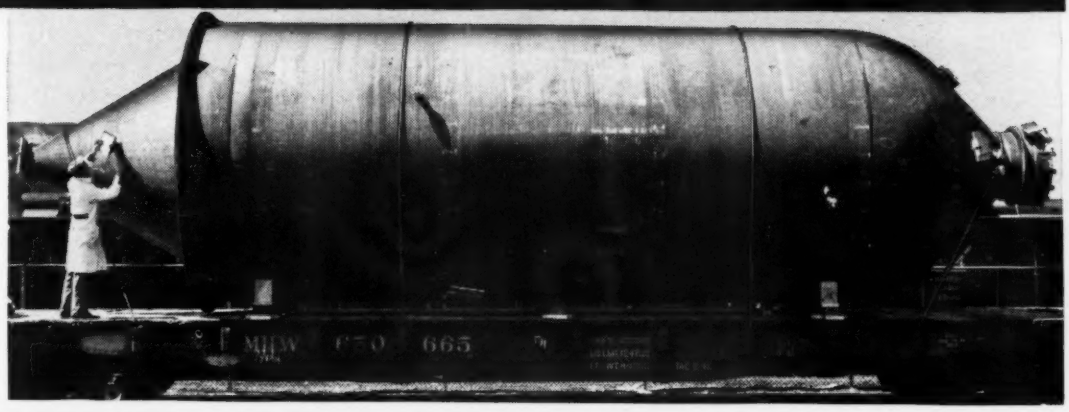

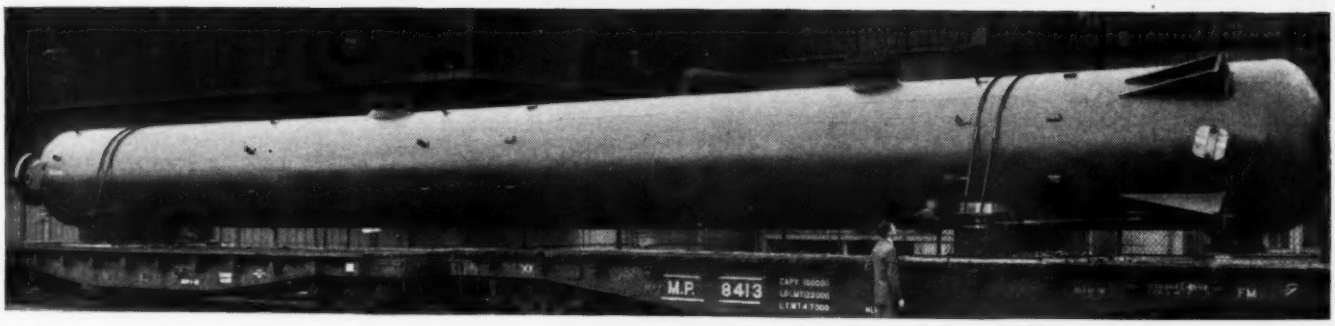

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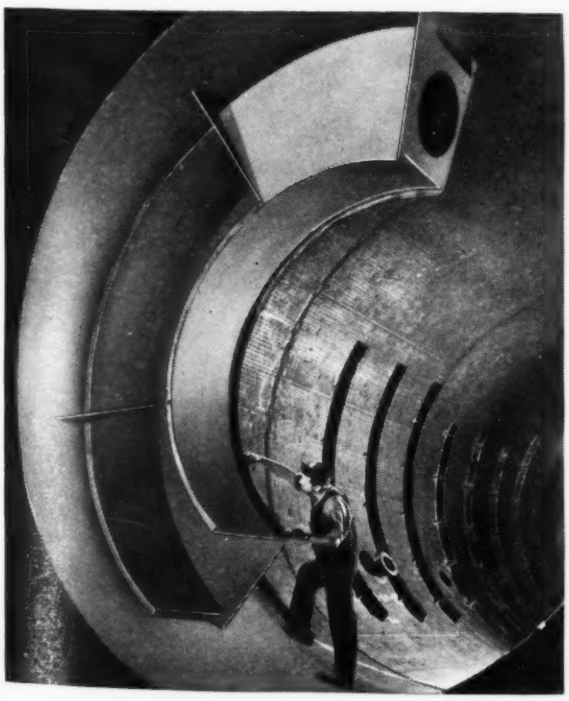

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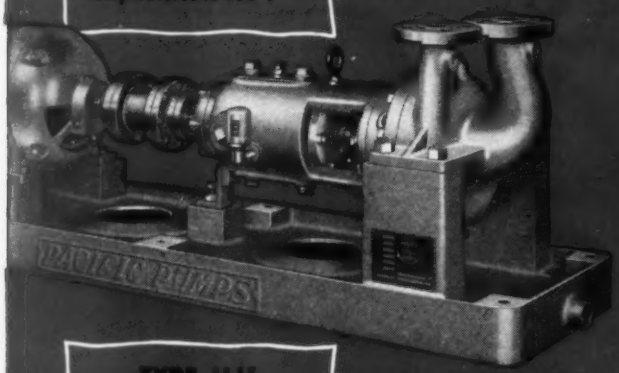

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was stated, however, that thermal reforming increases Research octane number to a greater extent than it does Motor octane number. Consequently, the Research method favors the economics of thermal reforming to a greater extent than would the Motor number.

TABLE 1—Estimated Yields and Gasoline Quality from Hypothetical Refinery when Reforming No Gasoline

Charges	b/d	Vol-% on crude
Crude	20,000	100.00
Purchased Butane	170	0.85
Products:		
Straightrun gasoline	6640	
Cracked gasoline	4010	
Propylene polymer	100	
Purchased Butane	170	
Total gasoline	10,920	54.6
Kerosine	2000	10.0
No. 2 Fuel Oil	3000	15.0
Bunker C	3820	19.1
Gas (fuel oil Equiv.)	900	4.5
Total products	20,640	103.2
RVP. of Gasoline	10 lbs.	
Oct. No.—Clear—Research	67.2	
+1 cc. TEL.	77.7	
+2 cc. TEL.	82.4	
+3 cc. TEL.	84.8	

Out-of-pocket operating cost of a thermal reforming unit in the hypothetical refinery included a fixed charge of $250/day for process labor, maintenance, and repairs; an incremental cost of $0.05/bbl. of naphtha reformed for the cost of fuel, water, steam, electricity, and chemicals; and an incremental polymerization unit cost of $0.50/bbl. of polymer produced.

Thermal reforming is most profitable at higher octane levels, the author stated. For example, in order to meet an octane number of 88, approximately 5 cc. of TEL would be required with no reforming at all. It would be necessary to reform to at least an octane improvement of 20 numbers regardless of the economics of so doing in order to meet the legal limit of 3 cc. of TEL per gal.

With respect to the effect of gasoline price on the economics of thermal reforming, it was said that a relatively small change in reforming severity will result in a large change in profits. With 10c/gal. gasoline, an increase in the octane improvement from 13 to 25 is equivalent to an increase of slightly over 5% in gas yield, and results in a loss of about $350/day.

In answer to a question during the discussion period: "If you were building a *new* refinery to use East Texas crudes, would you employ thermal reforming?" the author explained that it be necessary to be able to predict octane specifications for the next five or six years. If a catalytic cracking unit is planned for the new refinery, then a thermal reforming unit would probably be unnecessary. But if no catalytic cracking were contemplated, then thermal reforming should be used.

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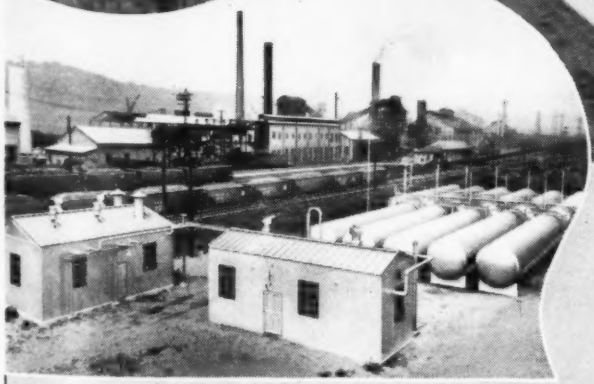

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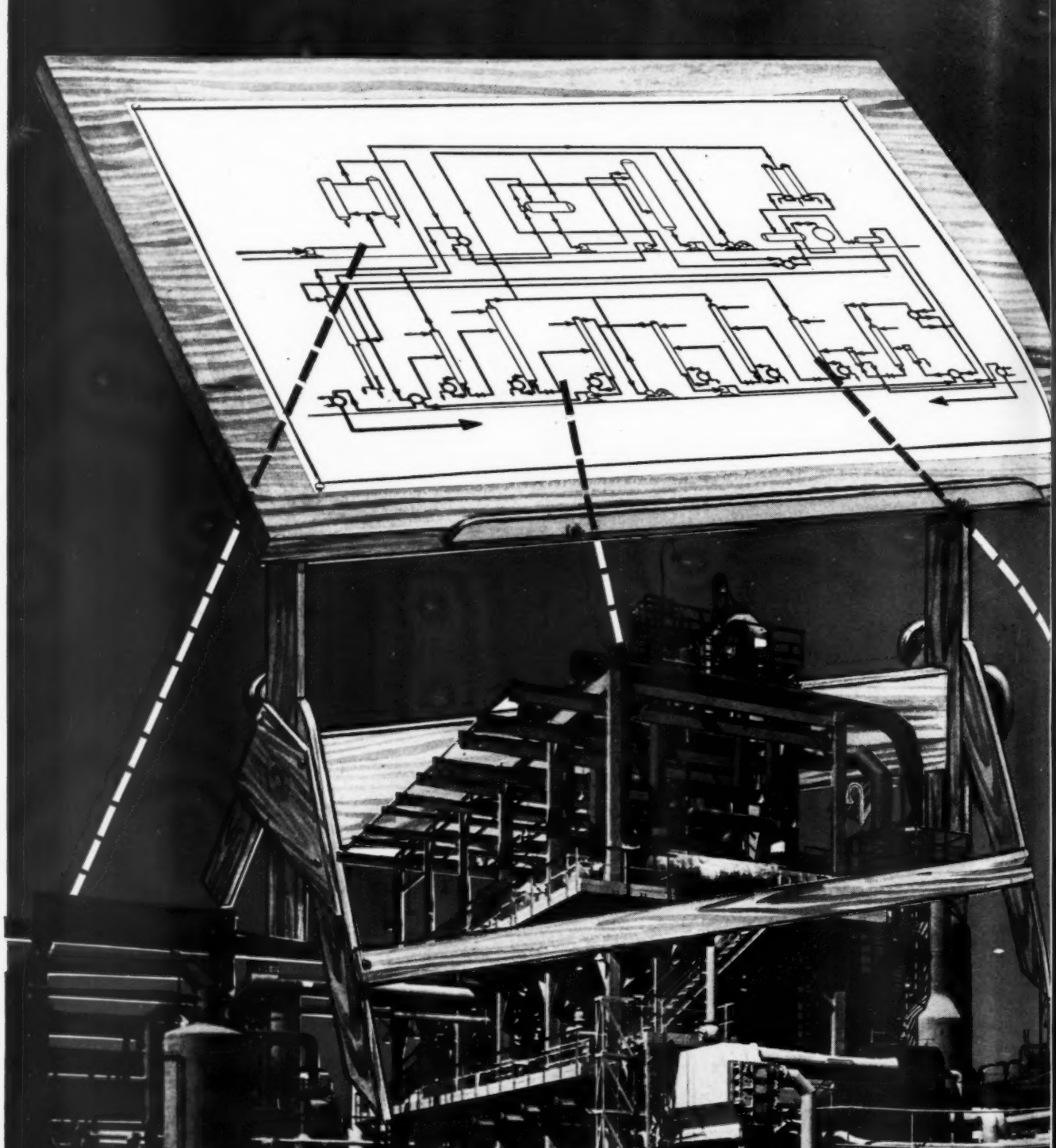

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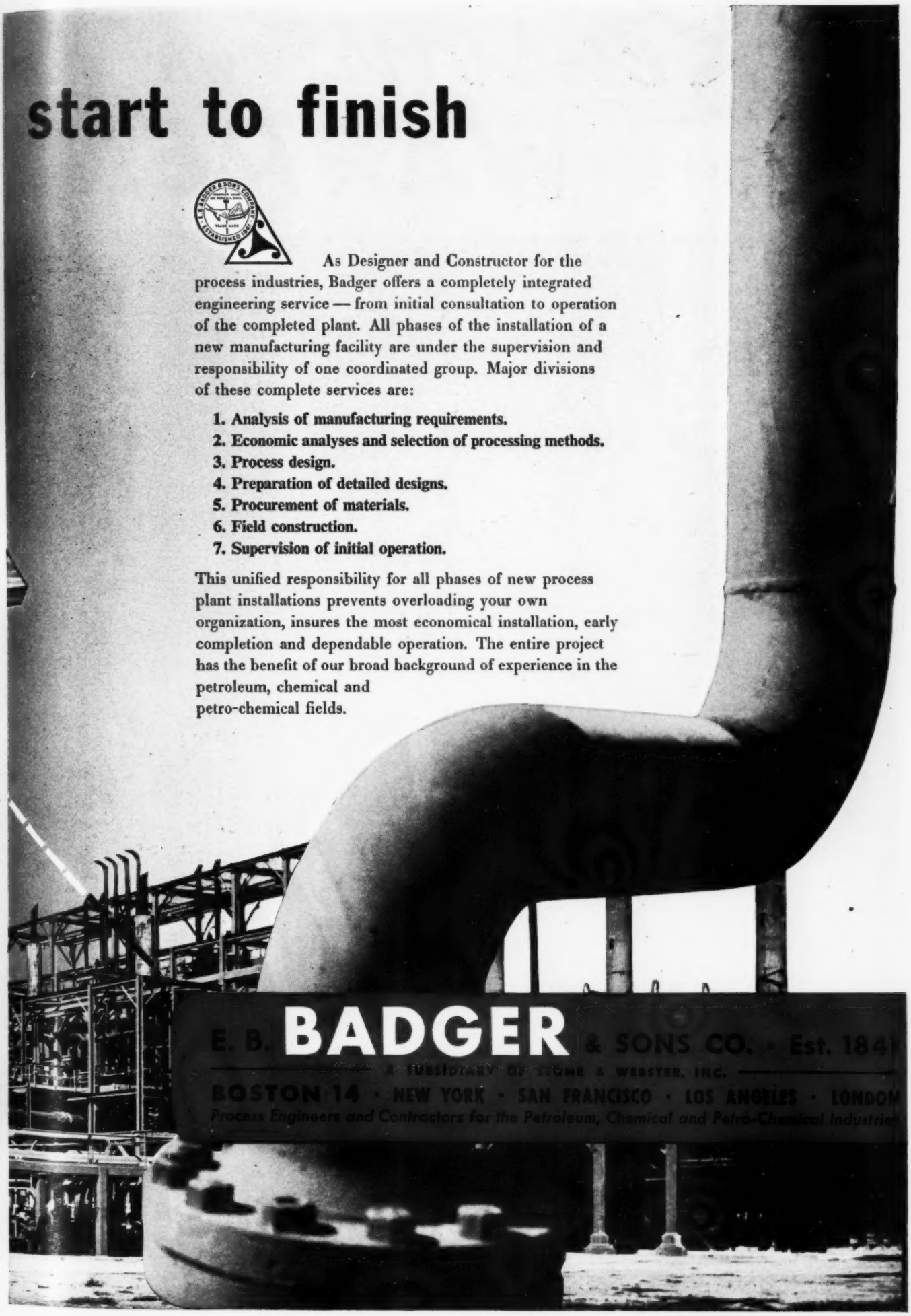

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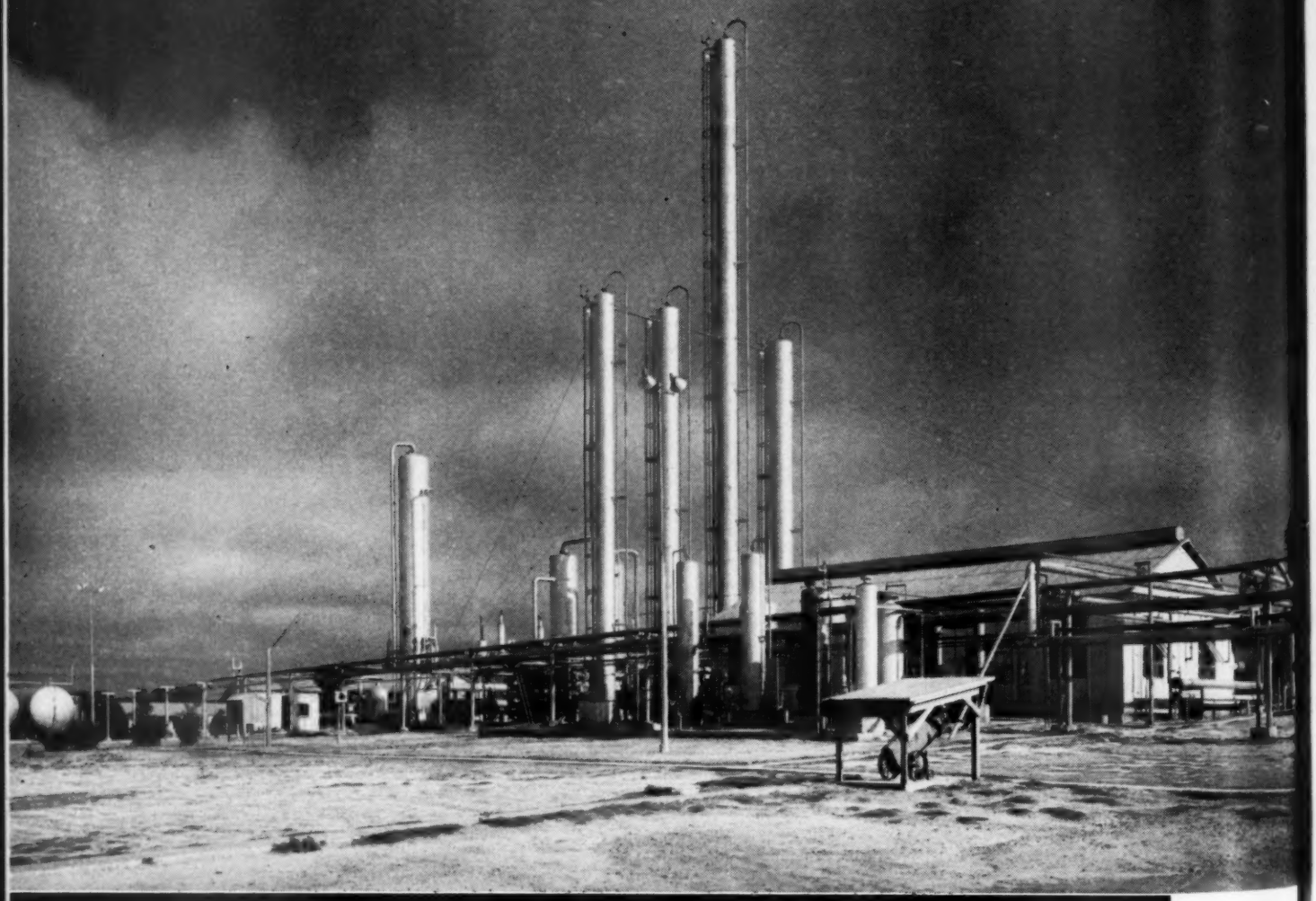

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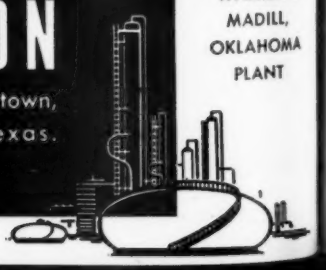

Crude Oil, Natural Gasoline and Liquefied Petroleum Products

Improved Test Methods for Natural Gasoline Reported to the NGAA

By D. P. THORNTON, Jr.
Southwestern Editor

REPORTS on their individual projects by technical committees of the Natural Gasoline Assn. of America were an important part of the program of its 28th Annual Convention in Fort Worth April 20-22. The reports included:

Improvements and modifications in various methods of tests used in determining product specifications.

Progress in the development of suitable inhibitors for lessening corrosion attacks in some gas-condensate wells.

Report on the proposal that the maximum allowable Reid vapor pressure be increased from 13.5 to 15 lbs. in winter time in northern areas of the U. S., as a means for including more butane in the motor fuel.

From the plant operators' standpoint perhaps the most far-reaching announcements were contained in the report "Modifications in LPG Test Methods," given by H. A. Montgomery, Warren Petroleum Corp., Houston, chairman of the NGAA Technical Committee.

NGAA's Technical Committee has been engaged in examining LPG specifiication test methods for some time, so it can finally present recommended tests required by its specifications which will more nearly fit the industry's needs, modifying existing methods and equipment as necessary. Four principal criteria were set up by the committee, as a guide in its work, in which representatives of the California Natural Gasoline Assn. also took part. These are:

1. Have the proper manufacturing process, capable of producing a satisfactory product.

2. The test methods must measure all the properties affecting safe handling of the material.

3. All properties measured must determine suitability of product for its major end use.

4. Precision of tests must be matched to available manufacturing processes; the degree of precision being a compromise between manufacturing requirements and user needs.

Methods for determining corrosive sulfur, moisture, specific gravity and weathering of LPG have also been under study. In addition, sub-committees have studied low temperature fractional analysis and tests for determining liquid content of field gases, and these subjects were discussed by the respective chairmen.

It was pointed out that, while present LPG specifications call for a product free from hydrogen sulfide or corrosive sulfur compounds, no test method is specified for determining, the amounts of sulfur compounds present. The Technical Committee is sponsoring research at the University of Texas to develop a satisfactory test procedure.

Specific Gravity

A new method is under development for the determination of specific gravity of LPG under pressure. The present hydrometer method is regarded as unsatisfactory because of the amount of equipment breakage under test conditions and, too, results are not always accurate due to deformation of the hydrometer by the pressure necessary. A new method will be formulated shortly, using new equipment.

The new equipment consists of the present lucite cylinder, in which is installed a scale guiding a float attached to the scale by a gold chain. Uncorrected specific gravity is obtained by reading the scale opposite a calibration mark on the float. Float and chain are always submerged in the liquid, and the principle of measurement is quite similar to the conventional "Chainomatic" analytical balance. The float is hollow plastic and deformation may be prevented by filling it with ammonia under pressure, or some other material.

Numerous modifications of the vapor pressure bomb as used for LPG testing have been studied. In all probability a modification will be selected wherein the equipment required will, for the most part, make use of most of the equipment now standard. However, simpler equipment in terms of use has been considered and it is intended to write a provision that will be written into the recommended test method whereby the use of existing equipment will be permissible. The present 105° F. temperature likely will be changed to 100° F., to conform to the temperature now used for gasoline.

There have been some criticisms of the existing method for determining moisture content by the cobalt bromide indicator. Investigations indicated the trouble lies largely in not permitting equilibrium to occur before the test is made and that the test should not be made from less than a 20-gal. container, 75% full. Precautionary notes are being added to the present recommended method.

Fractional Analysis Accuracy

The Fractional Analysis Committee has been conducting tests among laboratories to determine the group accuracy on the analysis of synthetic liquid samples. To date one sample has been analyzed and sufficient reports received for correlation. A. J. Miller, Phillips Petroleum Co., chairman of the committee, stated in his report, "The Accuracy of Low Temperature Fractional Analysis of Liquid Hydrocarbon Mixtures," that analyses generally were low for propane, closer to the true value for i-butane but with scattered results, high for n-butane, still higher for i-pentane and very close for n-pentane.

Results indicate a large volume of sample is unnecessary; closest results were obtained with volumes of 15 ml. or less. Time devoted to analysis also had a bearing on results. In general it was found that the highest accuracies were had with the less-rapid procedures.

Average deviations from the true value were reported for some of the hydrocarbons as −1.27 for propane; −0.90 for i-butane; +1.48 for n-butane and +5.5 for i-pentane.

The report cautioned that insufficient data were at hand to warrant recommendations for changes in techniques as yet, and also because two more samples are yet to be run. However, considerably less deviation was experienced than was expected, leading to the conclusion that much progress has been made in both analytical equipment and techniques in the past few years. Tentative conclusions reached by the committee indicate standardization of the equipment itself is not nearly as important as the "human element", including attention to equipment calibration, accurate following of technique, and equipment maintenance.

Definite progress has been made toward the solution of the gas-condensate well program, according to the report, "Cures for Corrosion in Gas Condensate Wells," given by W.

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H. Stewart, Magnolia Petroleum Co., Beaumont, chairman of the NGAA Corrosion Research Project Committee. In previous progress reports, it has been brought out that injection of certain inhibiting substances has done much to mitigate this originally mysterious corrosive attack in certain distillate wells. It has been found that certain natural inhibitors exist, preventing attack by carbon dioxide and certain organic chemicals naturally present in the well fluid. Likewise, the resistance of alloys to the attacks has been tried in numerous wells.

Investigations by the committee at the present time concern the nature of the natural inhibitors in order to identify them and establish the mechanism of protection. Much of this work is being done at the University of Texas. From some of this work, discoveries to date indicate that specific inhibitors can be compounded which will prove effective. From another phase it has been shown that corrosion rates are appreciably higher on surfaces covered by mill-scale than on "clean" surfaces under certain conditions. The Bureau of Mines likewise has been making extensive investigations of proposed inhibitors to determine their effectiveness — particularly sodium chromates in alkaline mixtures.

At the present time 48 wells are equipped with nickel alloy tubing and are under test; 46 more will be similarly equipped in the near future. Although alloy tubing costs approximately three times that of standard steel tubing, its use will be justified if it eliminates costly work-overs and repairs. Currently, insufficient time has elapsed on present installations to justify positive conclusions, but the report states there is a strong trend toward the use of alloys in combating this corrosion.

Vapor Pressure Recommendation

A progress report on the status of NGAA's efforts to secure acceptance of its recommendation to the ASTM Technical Committee A On Gasoline, for an increase in allowable winter vapor pressure to 15 lbs., Reid, was given by Kenneth Bottenberg, Phillips Petroleum Co., Bartlesville. He headed NGAA's Nowata Road Test(1) program from which data supporting the recommendation were secured.

On the basis of the road tests, NGAA proposed that ASTM Tentative Specifications for Gasoline, D 439-40T, increase the present maximum of 13.5 lbs. Reid vapor pressure to 15 lbs. in the northern areas of the U. S. during seasons where the average daily maximum atmospheric temperature does not exceed 55° F. Technical Committee A approved the recommendation for action by ASTM Committee D-2 this year and requested comments and suggestions also from its groups as well as from the SAE Fuels & Lubricants Committee, before committee D-2 took final action.

Advisory ballots on the question are currently being taken in the SAE Fuels & Lubricants Committee and Technical Committee A. The proposal will be subject to letter ballot by ASTM Committee D-2 before the forthcoming June meeting.

Some doubts have been expressed, by the automotive industry chiefly, in regard to the effect on trucks. These objections are based on their opinions of service complaints received from trucks using 11 to 13 lb. winter and 8 to 9 lb. summer gasolines. The report points out that very little test data are available which do not support the recommendation, while a very sketchy review of gasoline marketing service complaints from truck operators indicates but few which can be diagnosed as unquestionably vapor lock.

Present indications are that for the recommendation to be adopted into ASTM specifications it will be necessary to overcome these objections. This may not be accomplished before June, 1949. The NGAA recommendation has been materially assisted by Phillips Petroleum Co., which has supplied atmospheric temperature analyses and comparative vapor lock analyses between winter and summer gasolines. The Sun Oil Co. has supplied limited truck test data on 15 lb. gasoline. General Motors Corp. also is assisting by currently running limited heavy duty truck tests on proving grounds, using 15 lb. gasoline.

The report concludes that the outcome of forthcoming Committee D-2 action on the recommendation and better definition of the problem resulting from this committee's discussion will determine whether or not a special truck vapor lock test program will be worthwhile.

A report, "Tests for Determining the Liquid Content of Field Gases," of the NGAA Field Gas Testing Committee was made by W. H. Vaughan, Tide Water Associated Oil Co., Houston, chairman. This group has been reviewing test methods determining relative liquid content of field gases and is preparing recommendations to improve accuracy and duplicability. On the basis of comparative data between laboratory and field determinations, the tentative conclusion seems justified that there is a direct correlation between low temperature fractional analyses and the charcoal method for low liquid concentrations, and for richer gases the scattering of data makes unjustifiable any correlations as yet.

References

(1) Anon., "Road Test Data Supports Greater Use of Light Ends in Winter Motor Fuels," PETROLEUM PROCESSING, Jan., 1948, p. 33-40.

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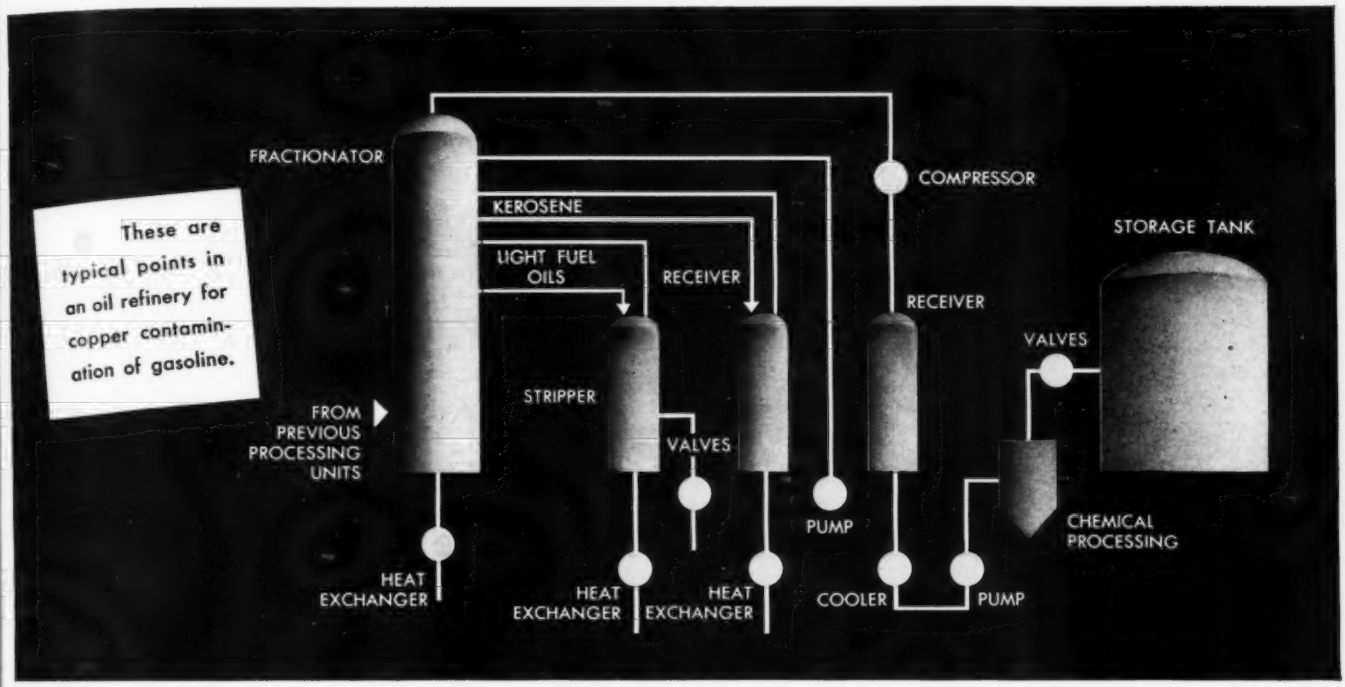

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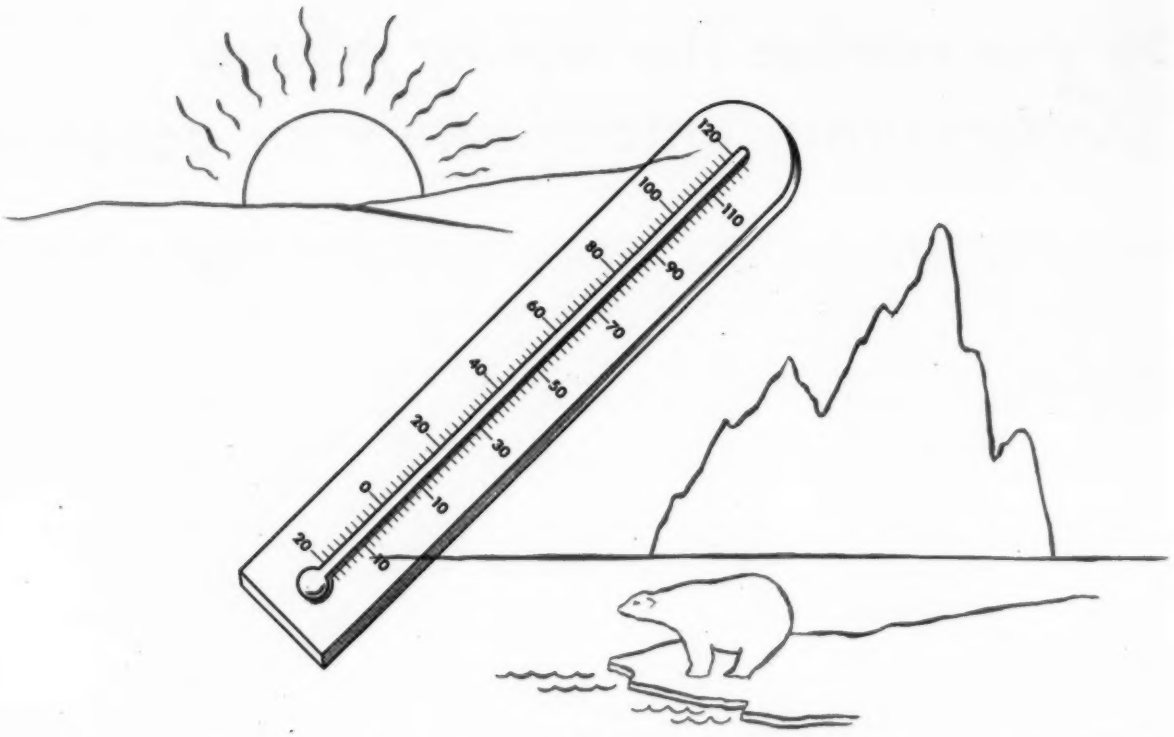

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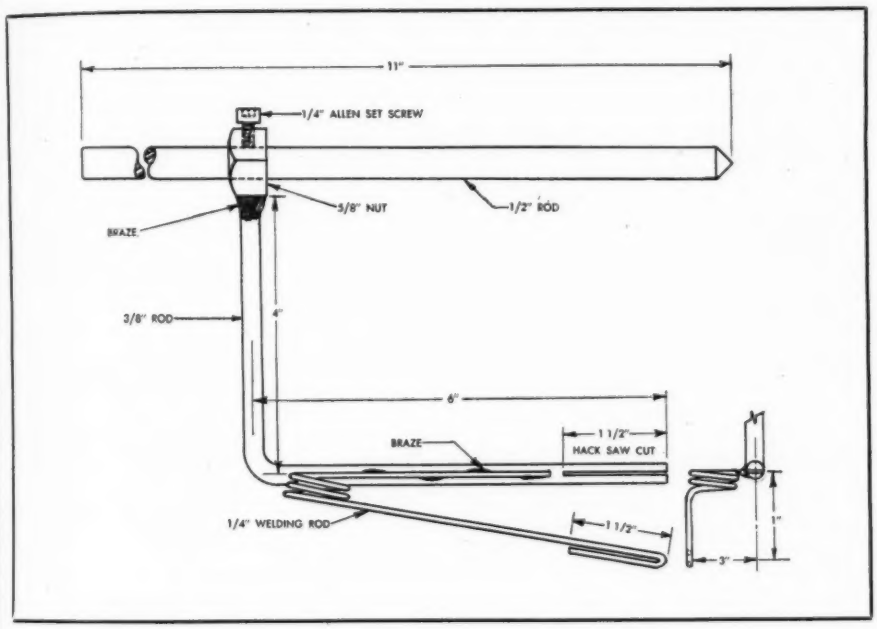
By R. A. BAINTER, Assistant Engineer
Frontier Refining Co., Cheyenne, Wyo.



MANY hours of tiresome labor in hand polishing scored crank pins and stub shafts on hot oil pumps can be saved by a simple sanding and polishing jig driven by a small, portable, electric drill.

Records kept by Frontier Refining Co. at the Cheyenne, Wyo., refinery, where the jig was developed, show that an 80% saving in time can be obtained with the tool. It used to take about five hours to polish two 7-in. diameter crank pins by hand, with frequent use of a micrometer to assure roundness. With the jig, the same operation can be performed in one hour with much less measuring.

Construction and use of the jig are illustrated in Figs. 1 and 2. The dimensions given are for a jig used on a 7-in. diameter crankpin having an 8-in. bearing surface. However, the jig shown works satisfactorily on any shaft under 7-in. The sliding member can be altered in size to fit any shaft.

In most cases, the crank pins to be polished have a center lubricating hole, ⅝-in. in diameter, into which the ½-in. mandrel of the jig can be inserted and slid in and out, thus making unnecessary any adjustment of the side arm. However, a tapering point center was machined at the end of the mandrel for use on pins and shafts having only a small center hole.

The jig is made from an 11-in. piece of ½-in. steel rod for the mandrel; with an 11-in. piece of ⅜-in. rod, bent and brazed to a ⅝-in. hexagonal nut, for the side arm. This sliding side arm is clamped to the mandrel by the Allen set screw in the hex nut.

Tension on the emery paper is obtained by use of a spring made from ¼-in. welding rod brazed to the side arm. A hacksaw cut, about 1½ in. long, is made in the end of the side arm. The emery paper is wound once or twice around the end of the arm, then around the shaft to crankpin to be polished, and back to the spring arm. There it is fastened by passing it through the slot, as shown in the sketch, Fig. 2. The jig is rotated by a 200-300 rpm. electric drill. Tension on the emery paper may be varied by squeezing the spring arm when the emery paper is inserted.

The same jig can be adapted easily for polishing the ends of heater tubes by making a proper size plug to fit the tube end and drilling a center hole in the plug to take the mandrel.

Fig. 1 — Above: Frontier's sanding and polishing jig. Tip of the ½-in. rod (at right) fits into usual center lubricating hole in crankpin: left end is inserted in power drill

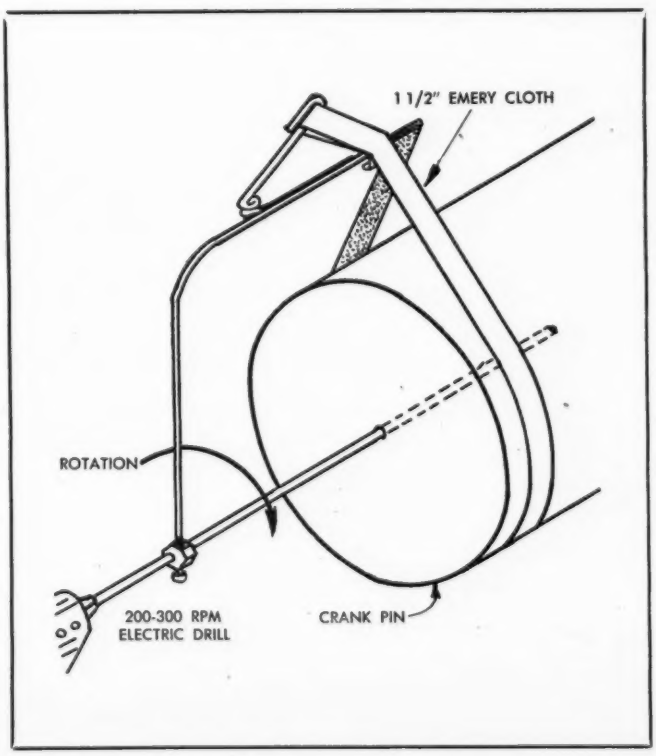


Fig. 2—Right: Method for fitting strip of emery cloth into jig and around crankpin. Entire assembly is moved in and out of center hole

Record Charts Improve Pump Maintenance

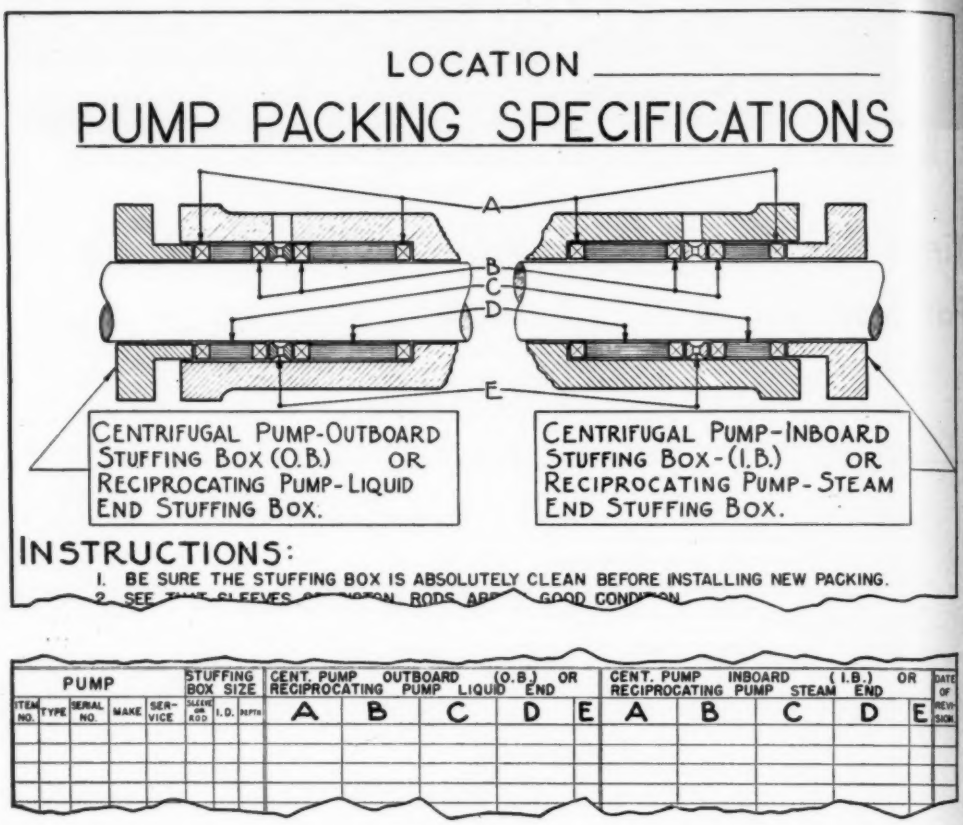


Fig. 3—Specification chart for facilitating pump packing maintenance as used at Atlantic Refining Co.

TO facilitate pump maintenance, the mechanical department at Atlantic Refining Co.'s Philadelphia refinery has installed complete specification and record charts at convenient locations in each pumphouse. The system enables repairmen to go direct to the pumphouse and find all necessary information on the job, thus eliminating the need for chasing down records in the maintenance office files. Pertinent parts of one such chart are shown in Fig. 3.

Actual dimensions of the chart are 19¼ in. wide by 29¼ in high. Underneath the sectional drawings of pump stuffing boxes is a list of 10 instructions (not shown in Fig. 3). They are as follows:

"1. Be sure that the stuffing box is absolutely clean before installing new packing.

"2. See that sleeves or piston rods are in good condition.

"3. Packing ring should have about $\frac{1}{16}$ in. gap at the joint.

"4. Make the joints of any two consecutive packing rings 180° apart.

"5. Immerse packing rings in a graphite oil lubricant to lessen starting up friction.

"6. Packing should be compressed every two or three rings. Use gland bolt nuts and split dummy bushing.

"7. Check proper location of lantern rings.

"8. When the last ring is compressed, back off the gland bolt nuts to finger tight.

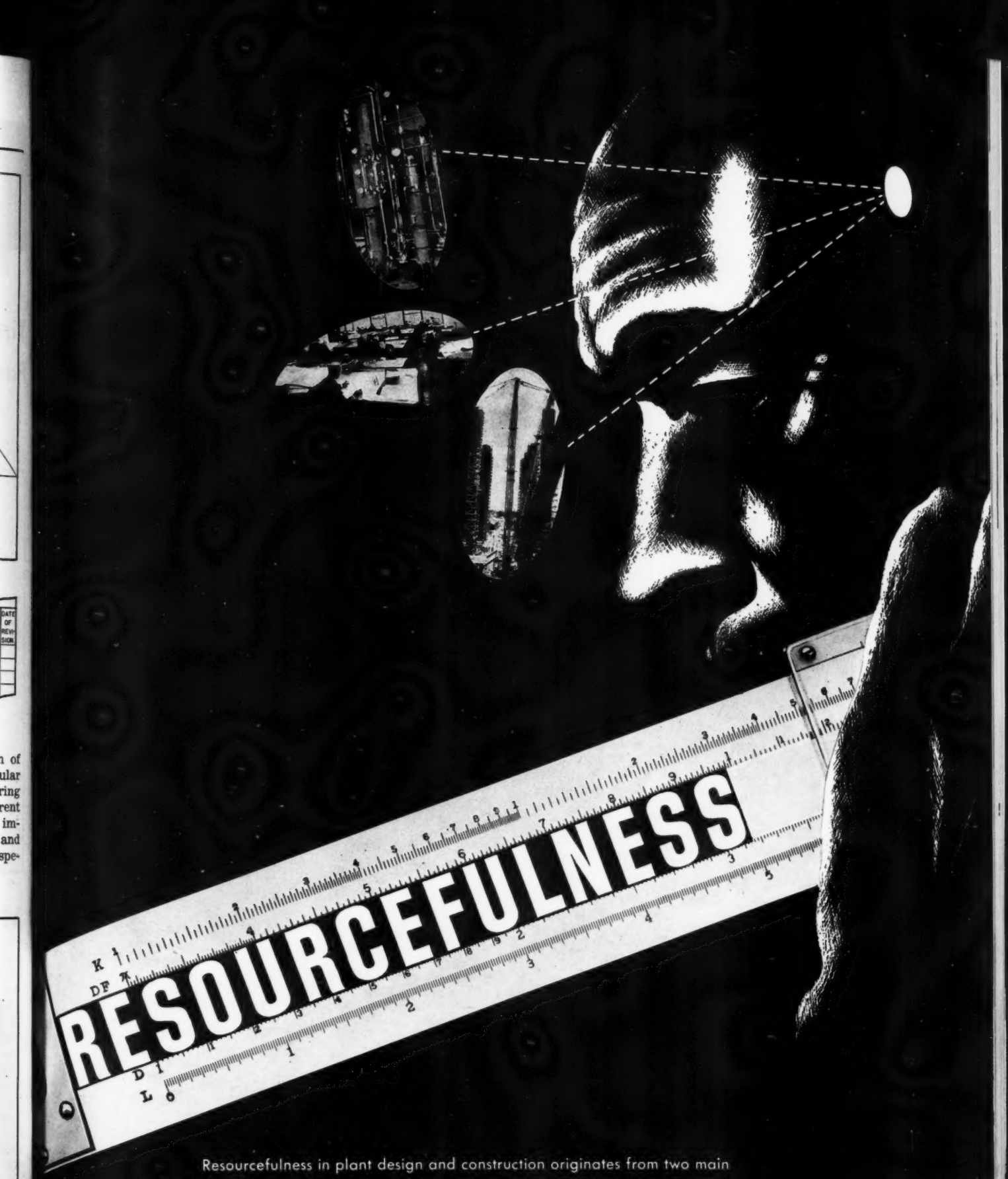
"9. Pack steam valve rods with the same kind of packing as specified for the steam piston rods.

"10. The number of packing rings required as shown in the table below is based on die-formed type of packing. When using spiral or coil type, it may require more rings than shown and should be reported."

In the record section, a portion of which is shown in Fig. 3, a tabular form provides space for entering data on as many as 25 different pumps. Vertical columns cover important information on pump and stuffing box as well as the five specifications A, B, C, D, and E.

Sturdy Door-stop Made from Scrap

When conventional door stops proved unsatisfactory on a long row of garage doors on one of the buildings in the East Chicago refinery of Sinclair Refining Co., plant mechanics developed and built a complete set of sturdy stops, a pair of which are shown in the accompanying photograph. A 3-in. angle iron about 2 ft. long is cemented in the ground in a vertical position, and a piece of ¼ or ½ in. scrap rod is shaped and mounted on the beam as shown. The stop forms a positive grip for the door and can easily be kicked into an "on" or "off" position.



Resourcefulness in plant design and construction originates from two main sources: First, the company's tangible strengths . . . laboratory facilities, engineering organization, manufacturing and construction equipment. Second, the capabilities of the *people* within the company organization in facing problems that require ingenuity and innovation.

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RESOURCEFULNESS in construction

Completion of this essential wartime plant faced a seemingly "unavoidable" delay:—the nation's entire shop capacity for tower and tank construction was already fully booked for equally essential work. Lummus met the emergency by building a complete pressure vessel shop on the site. Here, using modern time-saving methods such as automatic welding, towers and tanks for this and other vital war plants were fabricated on schedule.

RESOURCEFULNESS in planning

The problem here was to boost the capacity of a 10,000 B/D topping unit to 25,000 B/D without a serious break in output. By ingenious advance planning, the change-over was made with *only 72 hours downtime*. Nor was it just a "lucky accident"—for Lummus had assumed responsibility in its contract for this 72-hour time limit.

RESOURCEFULNESS in training

To erect this refinery in an isolated foreign location, local native labor was the only practical labor supply. Yet most of these people had never held a tool or even seen a welding torch. Lummus sent supervisors and foremen picked for their training aptitudes, backed them up with modern visual-education methods, organized a training school. "Graduates" were ready to meet erection schedules. Quality of workmanship met every test.

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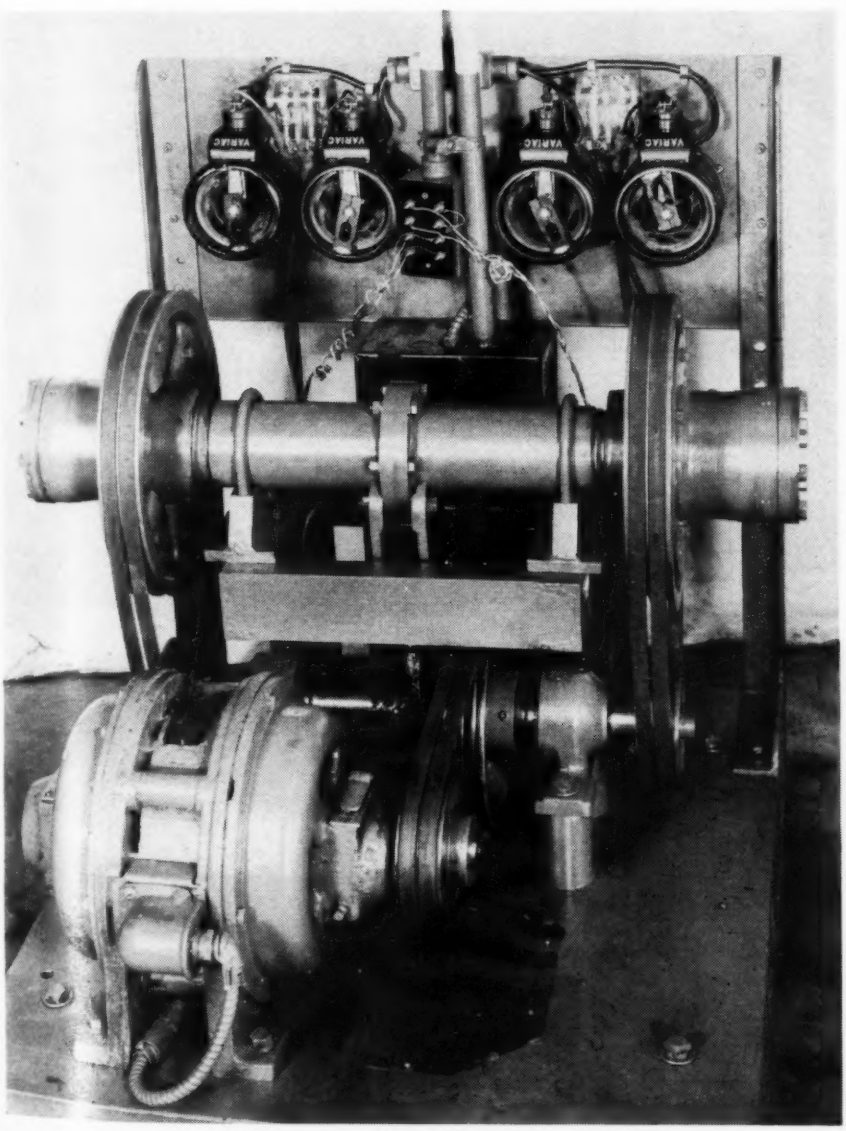
Laboratory Practices

Bearing Grease Takes Rigorous Tests On Device Simulating Road Vibration

ROAD vibration has proved to be an important factor in the retention of grease on automotive wheel bearings. In fact, vibration of any sort seems to give a decidedly strong effect on breaking down shear-susceptible greases.

A vibrating wheel bearing tester, developed and now in use at the Beacon, N. Y., research laboratories of The Texas Co., is one answer to the problem of evaluating greases under the most adverse conditions. It consists essentially of a rear axle hub assembly from a 1½-ton truck, that has been cut down to convenient length and utilizes standard spindles and tapered roller bearings.

Cartridge type electric heaters are positioned in the hollow spindle shaft under each bearing race. Thermocouples are placed in contact with the outer race of each bearing to determine bearing temperatures. The hub assemblies are mounted on a heavy metal frame, hinged at one side, and are pulley driven through a jack shaft from an electric motor. A vibrating motion of ⅜-in. amplitude is set up during each revolution of the hub by means of a connecting rod riding on an eccentric on the jack shaft.



The Texas Co.'s vibrating wheel bearing grease tester

Simple Steam Coil Is Useful For Heating Laboratory Air

By BLAINE F. NEWMAN
Chemical Engineer

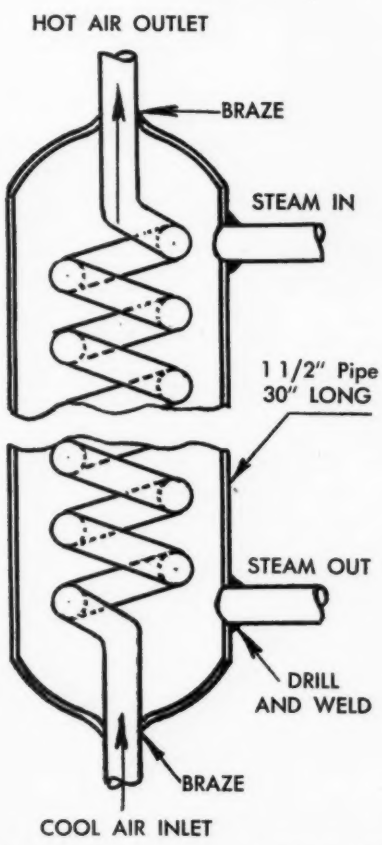
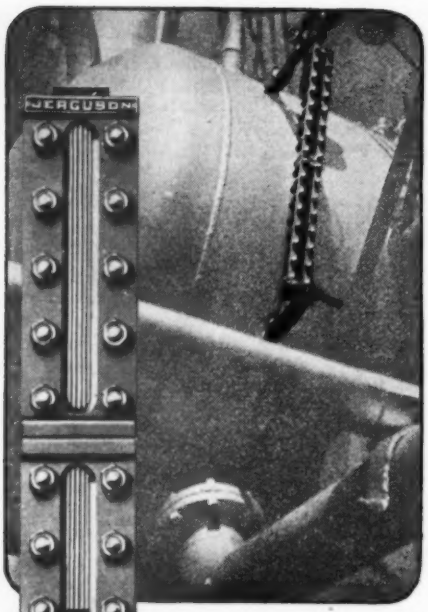


Fig. 1—Air heater for drying laboratory glassware

USING exhaust steam as a source of heat, a small coil-type heater installed at a compressed air outlet in the laboratory of one refinery provides a stream of hot air useful for drying glassware, or for any other



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purpose as the need arises. The device is shown in Fig. 1.

The coil is ¼-in. copper tubing, made from a piece about 8 ft. long and wound around a ½-in. diameter form. Approximately 25 turns are made, with enough left over at each end to extend through the ends of the 1½-in. standard pipe, 30 in. long, which serves as the steam jacket.

The jacket is necked down with a welding torch at each end so as to fit snugly over the copper tubing and the tubing is brazed into place. Short lengths of ¼-in. pipe are welded to holes at the top and bottom of the jacket for steam inlet and outlet.

Valveless Head Prevents Contamination Or Other Failure in Distilling Columns

By R. L. HOPKINS, Petroleum Chemist
Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla.

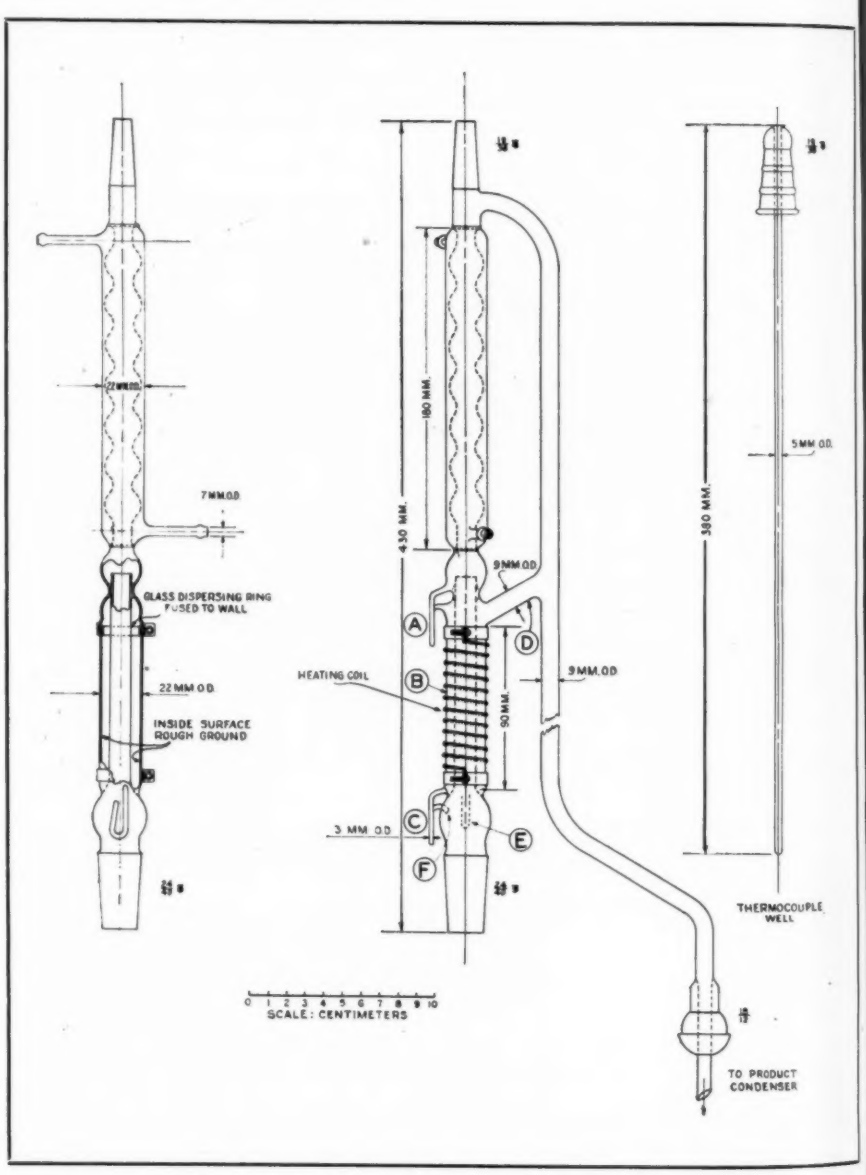

Fig. 2—Bureau of Mines' valveless distillation column head

MOST of the total condensation distilling heads in present use depend upon manually operated valves or stopcocks, or upon magnetically operated devices. The former require a lubricating agent in contact with the distillate, resulting in possible contamination, while the

latter are frequently subject to mechanical failure. The valveless head illustrated in the accompanying sketch (Fig. 2) was designed to minimize the above defects. It has been used in conjunction with 15- and 25-mm. diameter packed (glass helices) columns of about 120 cm. length and has given good service both in atmospheric and reduced pressure operation.

The vapors from the column pass upward through the center tube and are totally condensed. The reflux returns through U-shaped trap (A) onto a glass ring fused into the inner wall of tube (B), which disperses the liquid as a film flowing down the ground inner surface of this tube, returning to the column through trap (C), which also prevents vapors from the flask entering the re-evaporation annulus.

Evaporate Part of Reflux

The take-off is accomplished by re-evaporating a portion of the reflux from the returning film by applying current to the heating element, which consists of 10 feet of No. 30 B & S Chromel wire. The revaporized product is prevented from re-entering the reflux condenser by trap (A) and passes through outlet (D) into the product condenser and receiver line. Thermocouple well (E) is placed below the lower trap to avoid superheating. It is removable to allow the column to be packed or for removal of packing where the head is sealed directly to the column. Dropping tip (F) is provided for estimation of reflux rates.

For liquids boiling above about 50° C. good control of the take-off rate is obtained by connecting the heater directly to the output of a 0- to 115-volt variable transformer. For lower-boiling liquids smaller increments of voltage are required to obtain satisfactory control, and the output of the variable transformer is connected to a step-down transformer and then to the heater.

With either method of heating continuous take-off is achieved, which remains very constant on each distillation plateau and decreases automatically on the "breaks." With this type of operation the reflux returning to the column is heated.

Features of both intermittent and continuous take-off may be combined by operating the heater with an automatic timer having an "off" period of about 1 hour and an "on" period variable from 0 to about 20 minutes. Since the "on" period voltage may be adjusted over the same range as used on continuous take-off, this head becomes very versatile with respect to a wide range of reflux ratios, particularly when extremely low product rates are desired.

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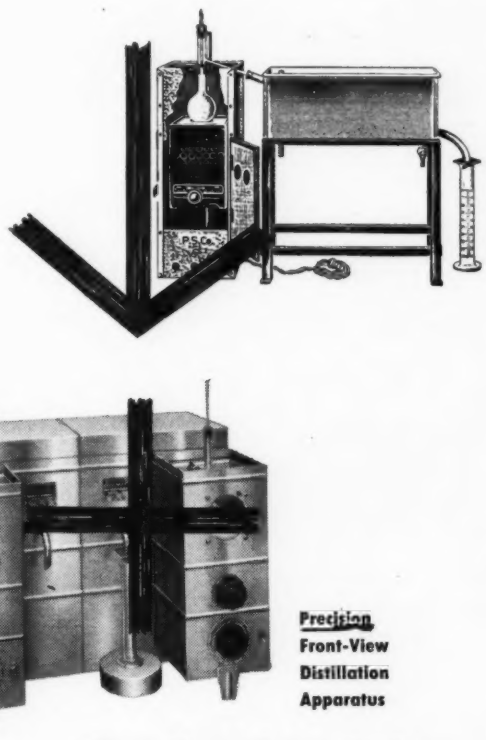

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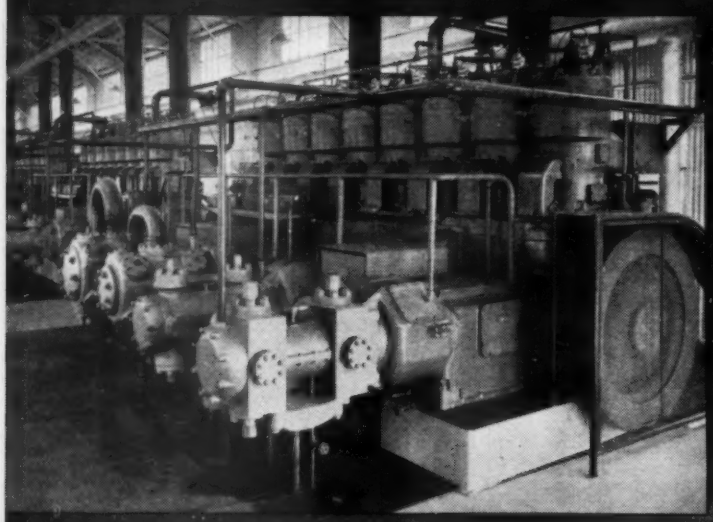
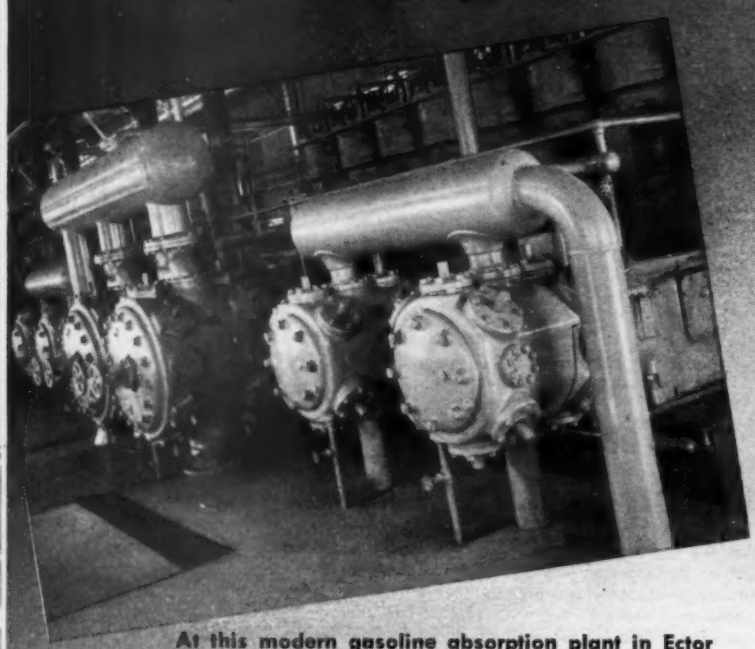
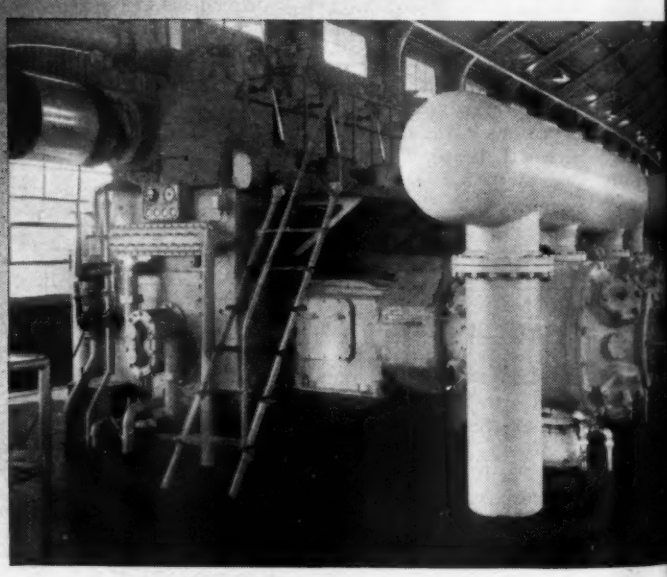


This Cycling Plant at Sinton, Texas, uses six Clark Right Angle, 8-cyl., 800-BHP compressors to repressure gas to the producing sands after the gasoline is extracted. This reclaimed gas was formerly burned off as flare gas.

In this modern gasoline absorption plant in Yoakum County, Texas, Clark Right Angle Compressors take gas from the field at pressures between atmosphere and 7 psig and compress it in two stages to 205 psig for processing.



At this modern gasoline absorption plant in Ector County, Texas, gas is taken in from the field at pressures between atmosphere and 7 psig and compressed in two stages to a final discharge pressure of 205 psig. Compressor installation shown here consists of eleven Clark 800-BHP Right Angles.



Several producing companies co-operated on this joint conservation project in Texas. This fine, modern plant is equipped with Clark 8-cyl., 1600-BHP "Big Angles", shown above. Flare gas is compressed in three stages up to 1000 psi and discharged into a pipe line for transmission.

CLARK { **SETS THE PACE IN COMPRESSOR PROGRESS**

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Probably the most important development in the petroleum industry in recent years is the spectacular progress made in conservation measures. Modern repressuring, recycling and gasoline absorption plants save untold quantities of gas and oil, both for current use and for the future, that would otherwise be wasted.

Clark Compressors are playing a major role in this great enterprise. In 1948, over 100,000 BHP of Clark units were installed in Texas alone, for use in conservation projects . . . Big Angles, Midget Angles and Right Angles.

Installed in an open shed, this 300-BHP "Midget Angle" is one of three on this Texas field, engaged in pumping gas back into the producing sands to keep up pressure. Semiportable, this compact unit is often called "the packaged compressor station".

In this plant near Beaumont, Texas, natural gas is gathered from the field, compressed and then put through an absorption process and natural gasoline is extracted. Residue gas is then utilized. Compressors are Clark 8-cyl., 800-BHP Right Angles.

The Clark "Midget Angle" is used extensively for conservation work. It lends itself to many field jobs where costs must be held down or where the location is hard to reach. Above—225-BHP "Midget Angle," skid-mounted, on gas lift service in the Hardin Field, Texas.

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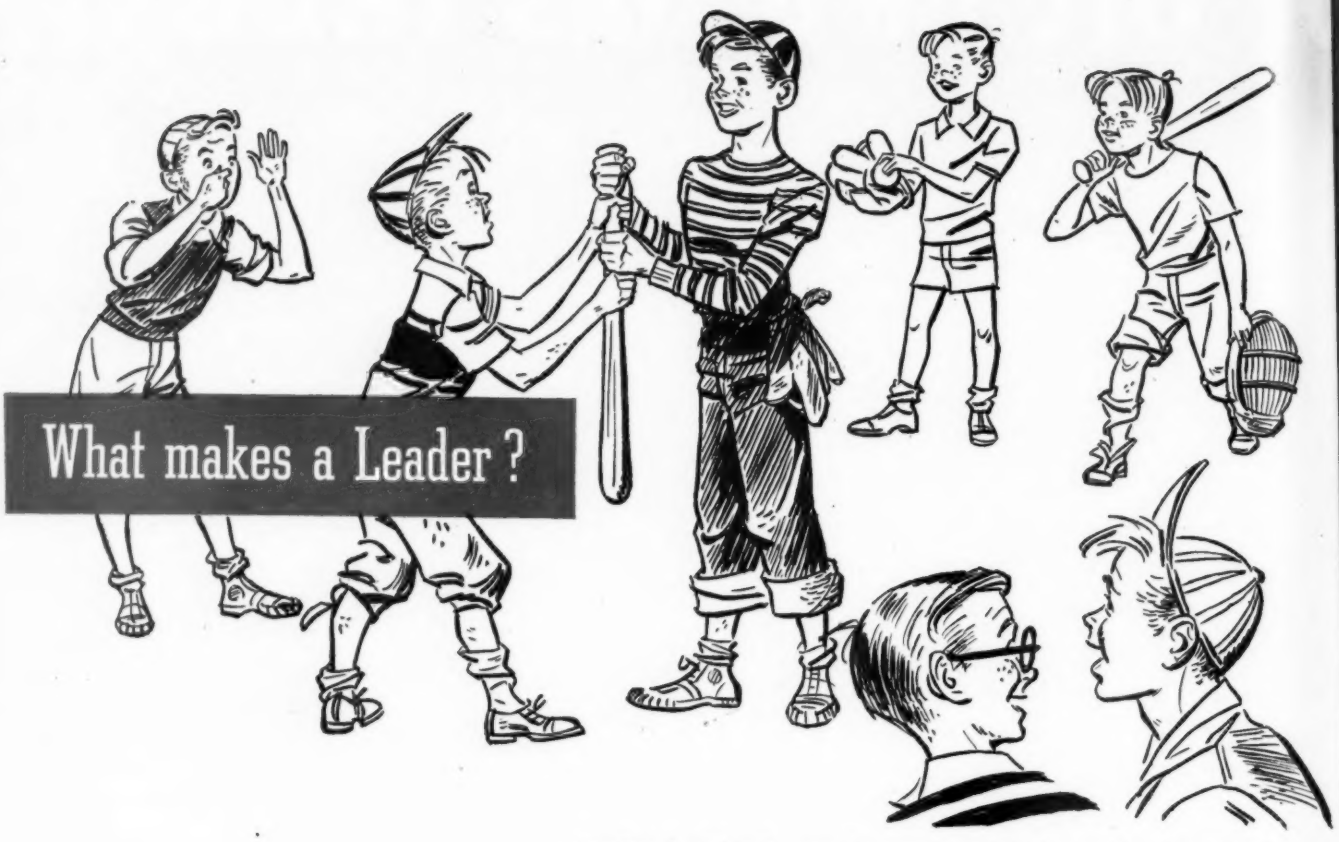

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Patent Trends in Petroleum Refining

By Peter J. Gaylor, Editor "The Technical Survey"

Apparatus Patents Newly Issued For the Alkylation Reaction

IF ONE WERE ASKED to name one factor in the petroleum industry which did the most in winning the last war, it would most likely be alkylation. In fact, even before the war, the Japanese realized the significance of this development and, as early as June 25, 1940, the Mitsubishi Trading Co. at San Francisco wrote a seemingly harmless letter to one of our petroleum magazines[1] asking for a list of companies having alkylation plants in California, their capacities, dates of construction and list of plants under construction.

The alkylation reaction of butene with isobutane is one of extreme apparent simplicity, and it is a wonder that the reaction was not discovered until about 1937.

The history of this development is an interesting one. In 1927, Ormandy and Craven[2] found that, by the use of 98% sulfuric acid, saturated open-chain paraffin hydrocarbons were obtained from olefins, rather than olefin dimers which were previously reported to be obtained with more dilute acids. In following up this anomalous result, the researchers fractionated cracked gasoline and treated each fraction by running slowly into it 98% acid, while stirring and cooling. The product was fractionated and found to contain heavy residues which, upon examination, proved to be open-chain paraffins of boiling point range similar to the product obtained from amylene.

Ipatieff[3] subsequently patented a process for producing high antiknock motor fuel by simultaneously subjecting a straight-run distillate containing gasoline hydrocarbons and cracked gases to the action of 85-95% sulfuric acid to form alkylated derivatives.

In 1936, Parks and Todd[4] discussed the thermodynamics of the reaction:

$$\text{i-}C_4H_{10} + \text{i-}C_4H_8 \rightleftharpoons \text{Isooctane}$$

proposed by Parks a year before. They concluded that "the relatively low temperature required and thermodynamic calculations coupled with inertness and low reaction velocities usually attributed to all paraffin hydrocarbons has made its feasibility appear dubious". "A recent development (Ipatieff's work with BF_3 and nickel at room temperature), however, indicates that the appraisal of the problem was perhaps premature. Accordingly, it appears that paraffins containing the tertiary carbon, i.e. isobutane, are by no means as inactive chemically as was previously supposed".

During the same year, Ingold[5] published some results on the deuterization of paraffin hydrocarbons, especially isoparaffins:

$$SO_3 + D_2O \rightleftharpoons D_2SO_4$$

$$D_2SO_4 + \text{i-}C_4H_{10} \rightleftharpoons \text{i-}C_4H_9 \div DHSO_4$$

It was shown that hydrogen exchange occurred more so with isoparaffins than with other hydrocarbons.

The influence of strong sulfuric acid in effecting hydrogen exchange in paraffin hydrocarbons was discussed at length by Ingold and coworkers, who were interested in introducing deuterium into paraffin hydrocarbon molecules. They found that, whereas 85% acid was effective in causing replacement of hydrogen in the case of aromatic hydrocarbons, acid strengths in the neighborhood of 95% were necessary with paraffins such as hexane. The most favored positions for exchange were considered to be the hydrogen-bearing carbon atoms which can acquire the strongest negative charge, i.e. tertiary carbon atoms and, to some extent, methylene groups adjoining branching points of the skeleton. It was concluded that the branched chain is the region of special reactivity, and that not only the methine group, at the branching point, but also the groups in proximity to it, undergo exchange with enhanced facility.

Sulfuric acid has been known as a hydrogenation catalyst, since it effects hydropolymerization of normal and iso-olefins[6] at room temperature, yielding both saturated and highly unsaturated hydrocarbons.

Ipatieff and Grosse had found in 1935 that halides of Al, B, Be, Ti, Zn, Hf, Th, Cb and Ta proved effective as alkylation catalysts. Boron fluoride alone was ineffective, but together with finely divided nickel (used previously by Otto and Bub[7] for polymerizing ethylene to butylene) and a small quantity of water, it was able to alkylate isobutane with ethylene or isobutylene, isopentane with ethylene, etc. Attempts to alkylate n-paraffins such as n-heptane, propane and methane, with BF_3 catalysts, did not prove successful. Later[8], n-paraffins, with the possible exception of ethane and methane, were successfully alkylated in pres-

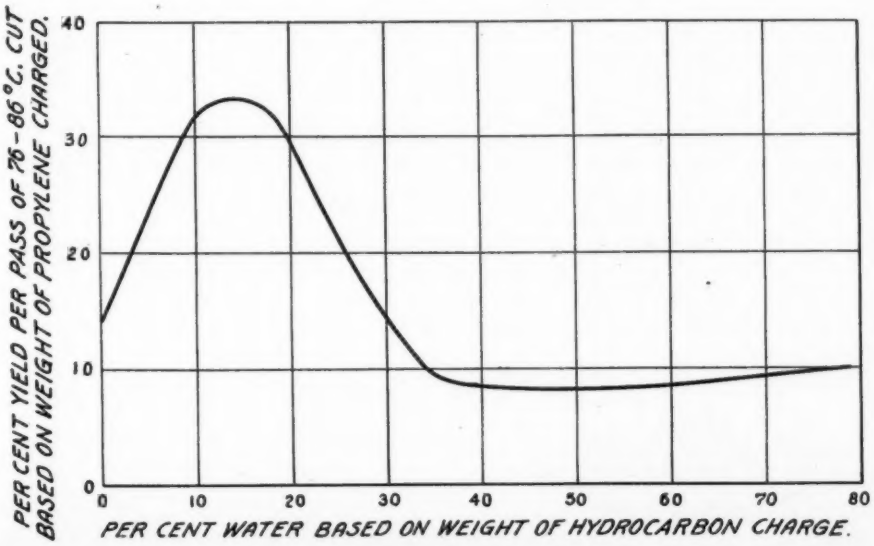

Fig. 1—Catalytic effect of water on alkylation reaction

ence of Zr, Al and other metal halides. Also, at about this time, both iso and normal paraffins from butane to decane were alkylated with ethylene, propylene, and butylenes, but higher paraffins had not been tried[9].

In 1937, Shell Oil Co. filed a patent application in Holland, and in 1938, Anglo-Iranian Oil Co. and Shell Oil filed in Britain[10] on the alkylation of isoparaffins with olefins with strong sulfuric acid to produce saturated isoparaffinic gasolines. By 1939, Humble Oil & Refg. Co. already had an alkylation plant in commercial operation.

The reaction had been developed rapidly during the war, when propylene and even ethylene were used with the raw materials to obtain maximum gasoline yields. A large number of patents issued in this field and we already discussed one[11] showing improved results by adding butyl phosphoric acid to the sulfuric acid. It would take up too much space to review all of these developments, but some of the more recent patents in this field might be discussed at this time.

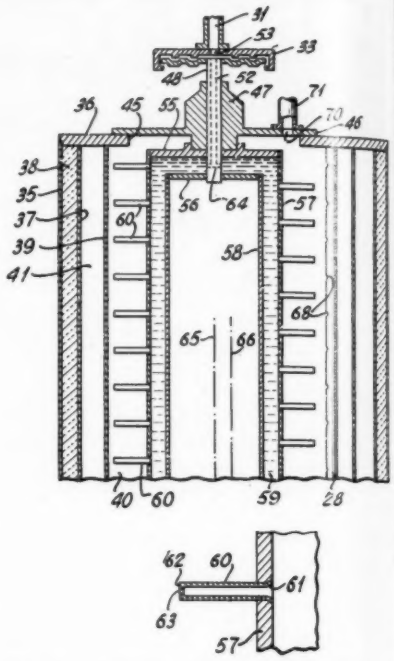

Fig. 2 — New alkylation reactor of Texaco Development Corp.

It will be recalled that several patents[12] issued in the past to Socony-Vacuum Oil Co. on the use of promoters in the alkylation reaction. A recent patent[13] issued to this firm, discloses the alkylation of isobutane with propylene to produce *triptane* in continuous operation. This reaction is carried out in gas phase at a pressure of 4500 psi and temperature of 850° F.

Under these conditions, a yield of alkylate (76°-86° C) of 21.4% is obtained, using no catalyst. However, when 19.2% of water is employed as an alkylation catalyst, the yield of alkylate is increased to 46.8%, with 6% being triptane. As can be seen from Fig. 1, the highest catalytic activity of water for the alkylation reaction takes place at a concentration of about 14% under these conditions.

Among the newer apparatus patents is one issued to Texaco Development Corp. Some time ago, this firm obtained a patent[14] on a multipoint olefin feed alkylation reactor designed to avoid local accumulation of olefin in the liquid alkylation catalyst. Recently, it has covered a Votator-type reactor[15] wherein the olefin is dispersed by multi-point addition from a number of hollow pins or fingers of an eccentrically mounted rotary cylinder rotating at high speed. A cross section of a portion of such a reactor is shown in Fig. 2, wherein fingers 60, provided with jets 63, are rotated in the acid-isoparaffin mixture 40, this reaction space being cooled by refrigerant in annular channel 41. Olefin is introduced through hollow shaft 52

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and then into the annular space in cylinder 57 from which it is ejected through orifices 63 while cylinder 57 is rotated via hollow shaft 31. Isobutane-acid mixture is fed along the reaction zone through the series of openings 68 in line 28, which insures the presence of isobutane in solution in the acid catalyst in the immediate regions of olefin dispersion from pins 60.

One patent[16] issued to Phillips Petroleum Co. discusses a method for overcoming the effect of water present in the ingoing reactant materials. Here, these materials are analyzed to determine the amount of water present, and sufficient sulfur trioxide is introduced into the reactor to react with all of the water so introduced. As can be seen from Fig. 3, the SO_3 is introduced at a point of entrance of the reactants before the alkylation reaction begins, thereby providing additional sulfuric acid for the alkylation.

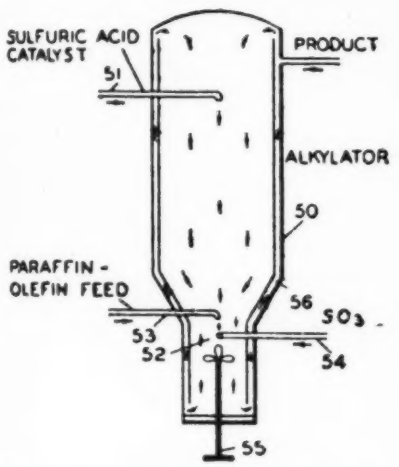

Fig. 3—Reactor employing water removal developed by the Phillips Petroleum Co.

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(2) Ormandy & Craven, *J. Inst. Petr. Tech.* 13, 311 (1927); *J. Soc. Chem. Ind.* 11/2/28 p.317T; cf. Norris et al, *J. Soc. Chem. Ind.* 3/22/29 p.70T, and Brit. Pat. 10,040/13 (New Process Co.)
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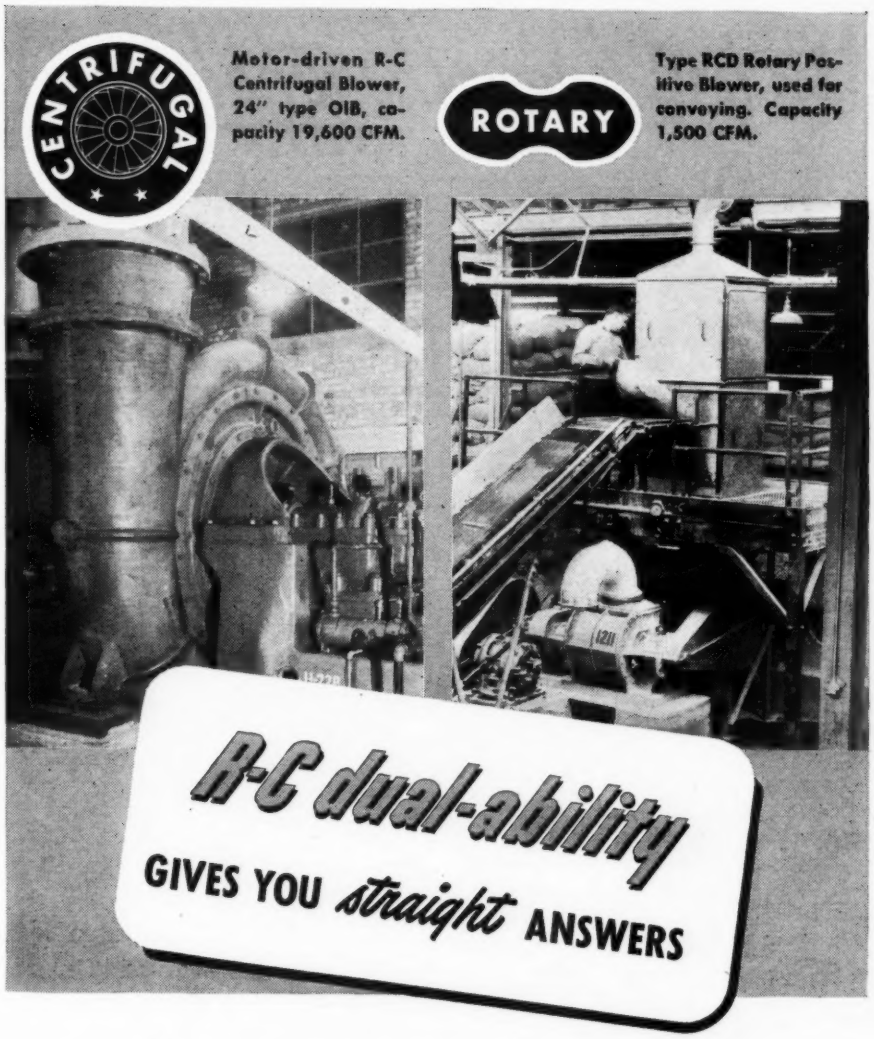
(9) Ipatieff et al, *J. Amer. Chem Soc.* 58, 913 (1936) Grosse et al, Paper ACS Mtg., Rochester 1937.
(10) Anglo Iranian Brit. Pat. 479,345, For. Pat. 824,914. Shell Oil Brit. Pat. 479,827. Fr. Pat. 824,329.
(11) Gaylor, PETROLEUM PROCESSING 4/47 p.264. U.S. Pat. 2,143,777 (Calif. Res. Corp.)
(12) Socony-Vacuum U.S. Pats. 2,410,107 and 2,410,072.
(13) Socony-Vacuum U.S. Pat. 2,460,719.
(14) U.S. Pat. 2,454,869 (Texaco Dev. Corp.).
(15) U.S. Pat. 2,463,262 (Texaco Dev. Corp.).
(16) U.S. Pat. 2,465,049 (Phillips Petr. Co.).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Strainer Is Made at Low Cost From Ordinary Pipe Fittings

In addition to the low cost pipeline strainer described below, this month's review of new and improved devices used in petroleum processing and handling operations on which patents have been issued recently includes:

- **Plug cock life increased by maintaining grease pressure**
- **Catalyst dust prevented from entering instrument lines**
- **Tough plastic improves seal in centrifugal pump bearing**
- **Transfer surface increased in redesigned heat exchanger**

INEXPENSIVELY CONSTRUCTED by welding together ordinary pipe fittings, which are relatively thin and elastic, a pipeline strainer is not liable to breakage by sudden changes in temperature and will withstand considerable distortion without damage, it is claimed.

As shown in cross section in Fig. 1, the body consists of a plain pipe nipple 10, closed at the upper end by a cap or bull nipple 11, preferably a forging. Inlet 12 is a 90° ell of the same diameter as the pipe in which the strainer is placed. Outlet 14, a plain nipple also, is in alignment with inlet 12. Both elements have half unions 13 and 15, and collars 26 and 27, for installing gages, blowdown connections, and the like.

The bottom end of body 10 is closed by plate 22, stud-bolted to a flange 16, which has its outer rim welded to body 10. A conventional type wire screen basket 19 completes the strainer.

Flow direction, it is stated, ensures against the collapse of the basket by external pressure in the event of choking of its meshes. As the basket is seated against the bottom closure plate 22, there is no tendency to dislodge it. The inner diameter of body 10 need be only slightly greater than the cylinder 19, because there is no accumulation of solids in the annular space.

U. S. 2,467,143, issued April 12, 1949, to Ora N. Mitchell, assignor to Parkhill-Wade, Inc., Los Angeles, Calif.

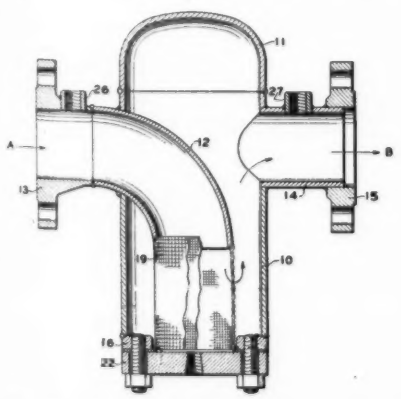


Fig. 1—Inexpensive pipeline strainer, built from ordinary pipe fittings (U. S. 2,467,143)

Plug Cock Life Is Increased By Holding Grease Pressure

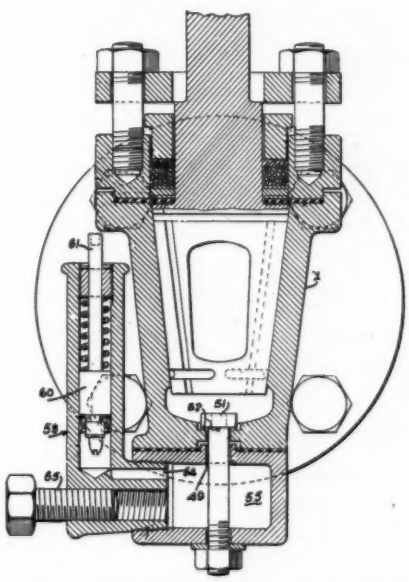


Fig. 2—Spring-loaded piston 60 maintains continuous pressure on the lubrication system of plug valve (U. S. 2,467,313)

CONSTANT LUBRICATION of a plug cock, especially of the type utilized for highly corrosive fluids where such lubrication is a requisite to long service life, can be obtained by augmenting the conventional set screw for applying pressure to the lubricant system with a spring-loaded plunger.

The mechanism is illustrated in Fig. 2. Lubricant compartment 55 is secured to the bottom of valve body 1 by a specially designed bolt 51, which permits passage of the grease to the valve through the annular space 49 and past the bolt head by virtue of the small ribs 52 on the underside of the bolt head.

Initial pressure on the system, provided by set screw 65, is maintained by means of the supplementary spring-loaded piston 60, acting through the connecting passage 64. In addition to providing continuous pressure maintenance, this plunger serves as an indicator of the lubricant supply. The position of the external pin 61 above the top of the plunger casing 58 moves down as the grease is depleted through leakage, etc.

U. S. 2,467,313, issued April 12, 1949, to Oystein Jacobsen, assignor to the Duriron Co., Inc., Dayton Ohio.

Stop Entry of Catalyst Dust In Instrument Lines, Orifices

A FLATTENED RUBBER tube will serve satisfactorily as a check valve in pneumatic type instrumentation on a Fluid catalytic cracking unit, for example, where the problem exists of minute particles of catalyst tending to enter and pack in orifices and

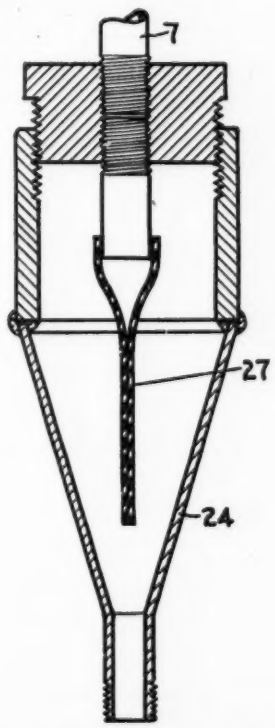
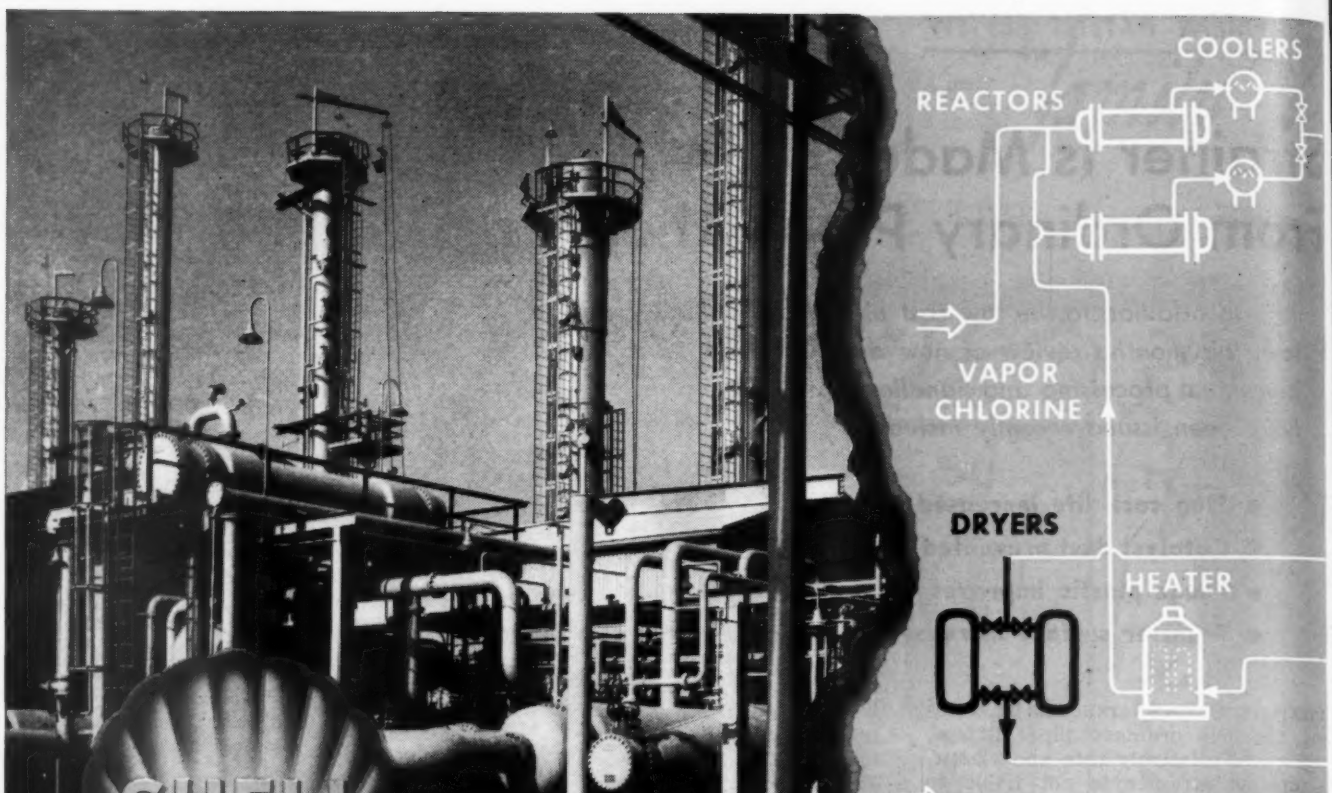


Fig. 3—Flattened rubber tube 27 acts as check valve in instrument lines of catalytic system (U. S. 2,465,628)



SELECTS **ALCOA ACTIVATED ALUMINA** FOR WORLD'S FIRST SYNTHETIC GLYCERINE PLANT

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conduits, thus affecting the correct operation of the instrument system.

The simple check valve is shown in Fig. 3. It comprises the flattened rubber tube 27 contained within a small, conical, metal housing 24. Normal, operating flow of instrument fluid is from inlet 7 through the valve. It is stated that the tube will offer a negligible resistance to the normal flow. Any back surge, of even the slightest pressure, will seal immediately the rubber lips and prevent passage of the finely divided catalyst.

A part of U. S. 2,465,628, issued March 29, 1949, to Lawson E. Border, assignor to Shell Development Co., San Francisco, Calif.

Tough Plastic Improves Seal In Centrifugal Pump Bearing

USE OF A SEAL of tetrafluoroethylene plastic resin will provide a tough, long-wearing, corrosion-resistant, and satisfactorily leak-proof element for shaft seals, particularly those in centrifugal pumps, where the high speed builds up considerable pressures within the casing and causes creep of fluid along the shaft to the bearing.

A form of the invention is shown in the sketch in Fig. 4. Immediately next to the conventional graphite sealing ring 9 is the cup-shaped member 10 of tetrafluoroethylene, in which the recess 11 is fairly deep. Tapered surface 12 is at about 15° to the longitudinal axis of the shaft.

Following the plastic cup is a gland 13 with a corresponding tapered surface which forms a perfectly fluid tight seal when in contact with surface 12. The gland preferably is made of an alloy suitable for its resistance to the fluid being handled in the pump.

U. S. 2,467,312, issued April 12, 1949, to Delbert E. Jack, assignor to The Duriron Co., Inc., Dayton, Ohio.

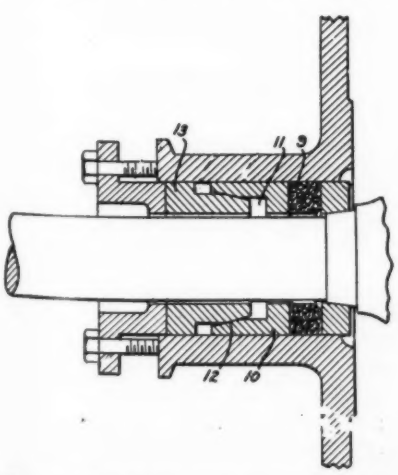

Fig. 4—Fluid-tight seal is provided by tetrafluoroethylene part 10 (U. S. 2,467,312)

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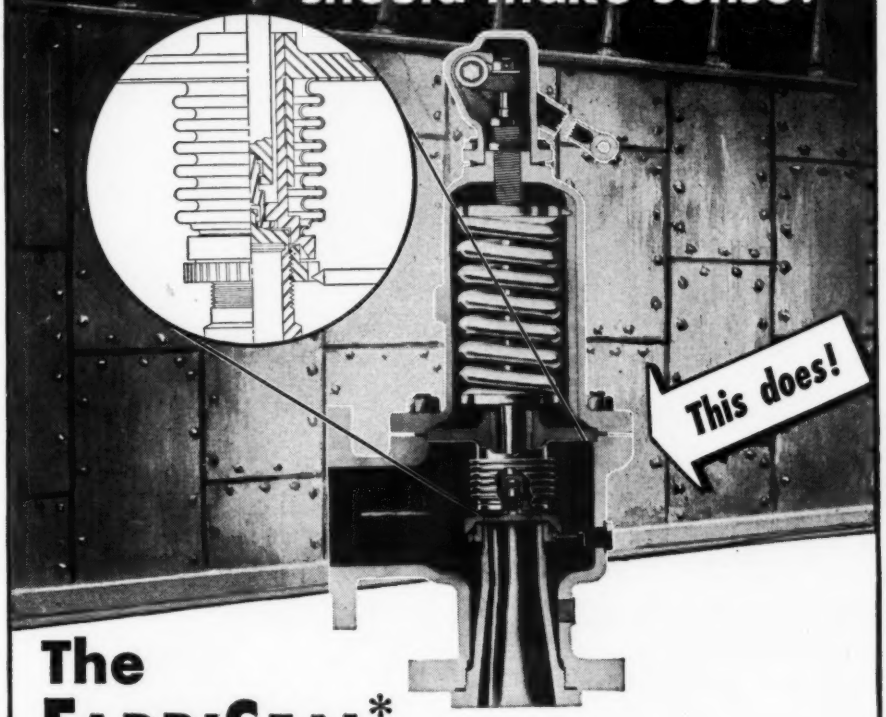

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Equipment Patent Review

Transfer Surface Increased In Heat Exchanger Redesign

THE AMOUNT OF HEAT transfer surface accommodated in a given shell of a hairpin tube type heat exchanger can be increased by utilizing groups of tubes with varying lengths so as to locate the hairpin turns in a nesting arrangement, as illustrated in Fig. 5, which shows a portion of the end of such an exchanger.

The longest tubes, indicated generally by turns 32, constitute the first pass along the bottom of the shell and the second pass along the top. Third and fourth passes are nearer the center of the shell and are indicated by turns 20 and 21. The arrangement is said to be particularly useful for a horizontal shell where the first pass tube portions are at the bottom and are used to sub-cool condensate resulting from condensation of vapors by the other passes.

U. S. 2,467,741, issued April 19, 1949, to Chester F. Hancock, assignor to Westinghouse Electric Corp., East Pittsburgh, Penna.

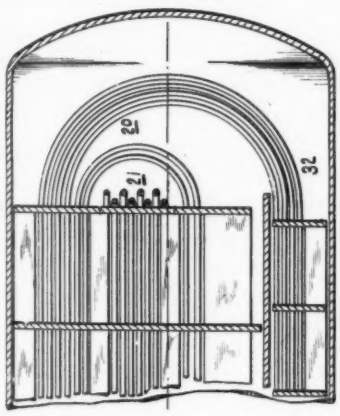


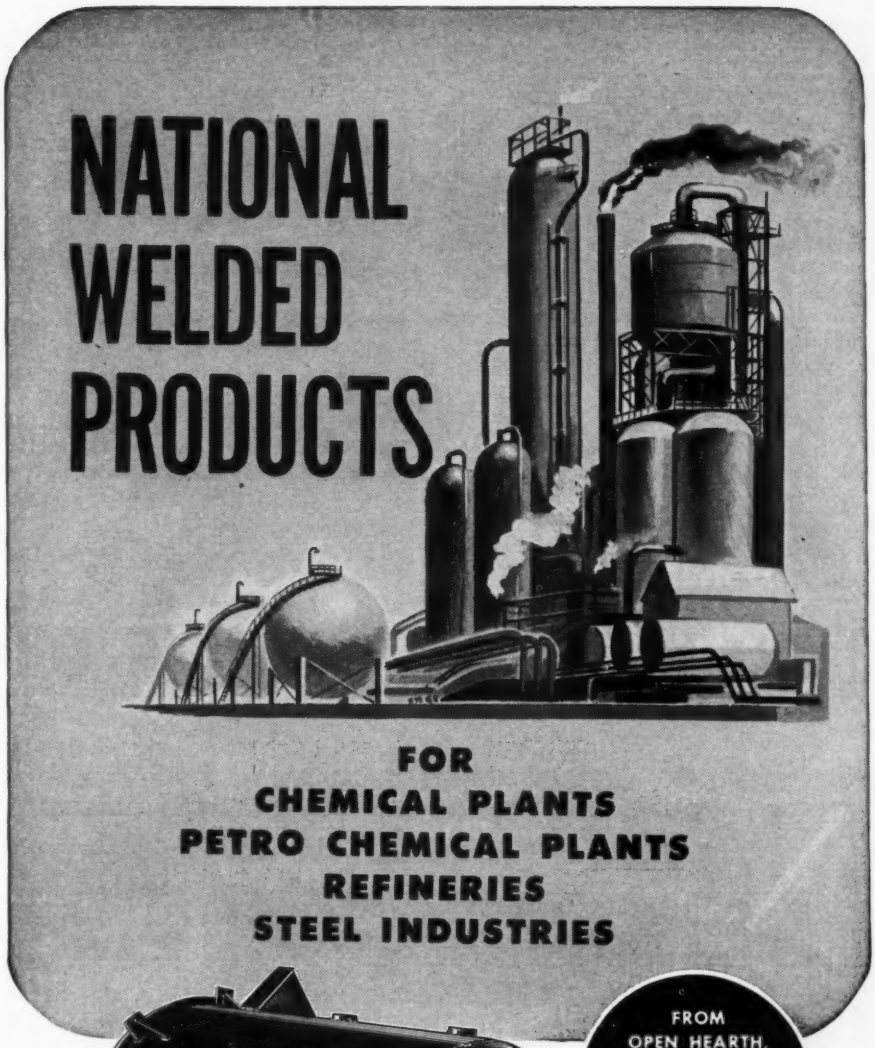
Fig. 5—Hairpin tube heat exchanger arranged for increased tube surface (U. S. 2,467,741)

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with the greatest interest.

Catalyst Stripper in which the ratio of length to diameter has been raised by subdividing the stripping zone into a series of cells or sections separated by vertical partitions. U. S. 2,467,850, issued April 19, 1949, to H. J. Ogorzaly, assignor to Standard Oil Development Co., New York, N. Y.

Reaction Vessel which will produce low cost heating gas from water and



low grade hydrocarbon oils such as refinery residua and waste crank case oil. U. S. 2,465,666, issued March 29, 1949, to Virgil Stark, New York, N. Y.

Crank-actuated Gear-drive socket wrench which enables the operator to use it in close spaces where conventional style wrenches cannot be operated. U. S. 2,466,456, issued April 5, 1949, to B. H. Lybyrer, Casper, Wyoming.

Jet-type Pump for shallow or deep well service which can operate from greater depths than is possible with conventional jet pumps; utilizing a supplementary centrifugal pump for withdrawing fluid delivered by the ejection unit. U. S. 2,466,792, issued April 12, 1949, to W. J. Conery, assignor to F. E. Myers & Bro. Co., Ashland, Ohio.

Liquid Level Indicator for closed tanks operating at relatively high pressures and temperatures, employing a pneumatic device of the so-called "null" type for transmitting the signal to an indicating instrument. U. S. 2,467,365, issued April 19, 1949, to D. H. Annin, assignor to The Grove Regulator Co., Oakland, Calif.

Leak Detection and Recovery of liquid in storage tank bottoms is provided by a series of troughs attached to underside of tank bottom and running along with various seams. U. S. 2,460,054, issued January 25, 1949, to John H. Wiggins, Chicago, Ill.

Tube Expander with an expansible ball drift which can be readily and quickly applied, removed, and changed; the entire unit being operated by the conventional hammer end of a pneumatic hammer. U. S. 2,459,808, issued January 25, 1949, to George A. Geyer, New York City.

Floating Roof for storage tanks with employs a flexible fabric material for both the vertical curtain section and the horizontal diaphragm section; such material to be resistant to hydrogen sulfide and weak sulfuric acid; additional sealing liquid is maintained above the floating diaphragm so as to avoid frictional wear and other mechanical damage. U. S. 2,461,537, issued February 15, 1949, to Alexander S. Feild, assignor to Shell Development Co., San Francisco, Calif.

Pipe Mitering Equipment for cutting large diameter pipe accurately; comprising an adjustable jig for holding a cutting torch and allowing the pipe to be rotated as the cut is made. U. S. 2,459,823, issued January 25, 1949, to Michael N. Lebedeff, assignor to Chicago Bridge & Iron Co., Chicago, Ill.

Floating Roof for storage tanks with diameters of 60 ft. or less, in which the annular compression member is not a pontoon. U. S. 2,460,053, issued January 25, 1949, to John H. Wiggins, Chicago, Ill.

Self-priming Centrifugal Pump which combines a peripheral jet with a central jet priming mechanism in order to substantially reduce the time required for priming and further to prevent cavitation in the impeller wheel. U. S. 2,466,812, issued April 12, 1949, to Oystein Jacobsen, assignor to the Duriron Co., Inc., Dayton, Ohio.

How to Obtain Patents

Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number direct from: The Commissioner of Patents, Washington 25, D. C.

TWO WAYS OF BURNING OIL

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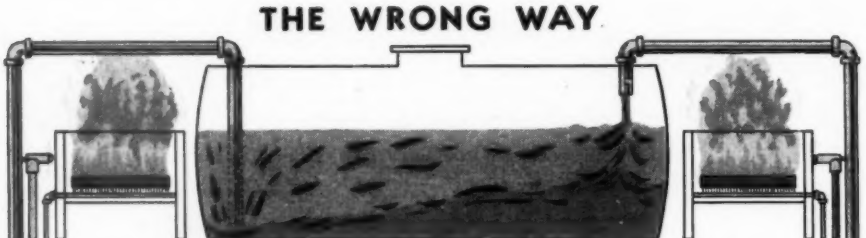
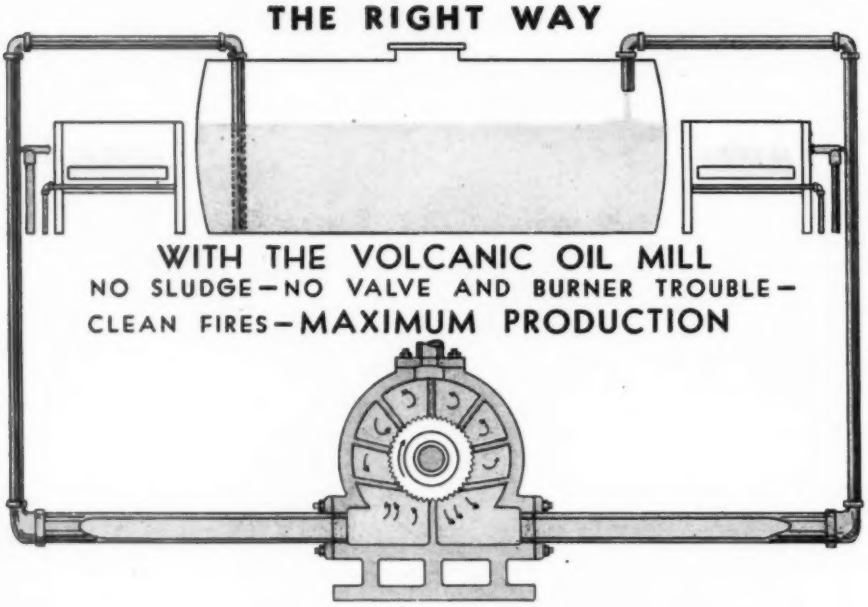


SLUDGE IN STORAGE—VALVE AND BURNER TROUBLES—
UNBURNED OIL—LOST PRODUCTION

THE RIGHT WAY



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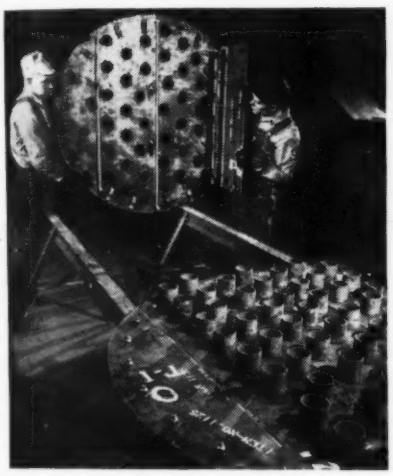
Reviewed by WILLIAM C. UHL, Equipment Editor

1—Sectional Bubble Tray



A new panel-type, sectional tray for fractionating equipment is light in weight and fabricated in such a way that it can be either removable or permanent. Its parts are removable in sections so they will pass easily through a manhole and can be handled easily in the field. The sections are crimped together to form a coupling and to strengthen the tray. Tray sections are held in line and attached to supporting bars or angles in the tower by an especially designed clamp. The clamps can be operated from the top or bottom side of the tray, or can be arranged to operate from the top only, as desired. In large diameter towers, separate beams can be used to support tray sections so that the assembled tray will meet any specified deflection tolerance. Sections can be made virtually leak-tight: tests showed a leakage of about 25 gals./hr. on a 72-in. tray. Wyatt Metal & Boiler Works.

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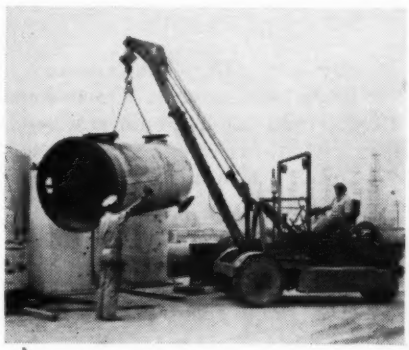
Use one of the attached reply cards to request additional information or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the rest of the card, and drop it in the mail. No postage required.

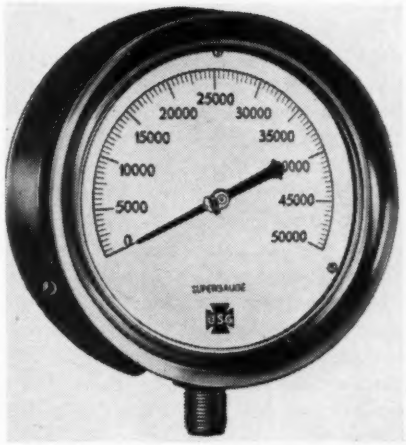
2—Maintenance Cranes

The "Krane-Kar" Mobile Swing-Boom Crane can be utilized for a wide variety of materials-handling jobs in maintenance departments of oil refineries, such as handling heavy vessels during installation or for routine repairs in moving heat exchangers, piping, pumps, stacks, etc. It is available in four models with load capacities of 1¼, 2½, 5, and 10 tons. Gasoline or Diesel operated, four speeds forward and one reverse —four speeds reverse optional. Pneumatic or solid rubber tires. Front wheel is traction, rear wheel is for steering. Crane will climb grades up to 20%, fully loaded. Silent Hoist & Crane Co., Inc.



3—Safe High-pressure Gage

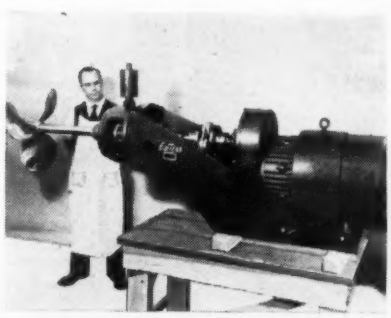
The U. S. "Supergauge" has been designed with a solid wall, cast integral with the case, which separates the Bourdon tube and movement section from the observer. The entire back is fitted with a spring-mounted safety release which in the event of a tube rupture will momentarily discharge the high pressure media away from the observer. Accuracy is said to be 1% of full scale reading on all



pressures up to 50,000 psi. and 2% of reading on pressures of 60,000 psi and over. United States Gauge.

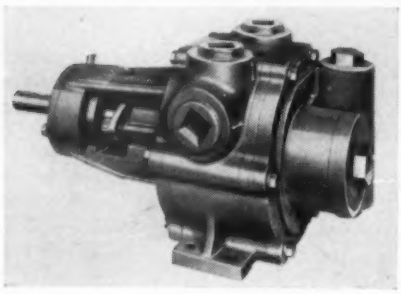
4—Mixer Repacked Easily

A new side-entering mixer has been designed with a stuffing box that can be repacked without emptying the tank. This is done by means of an outboard sealing ring which seals off the shaft while the packing is being replaced. The mixer is available in all sizes from 10 to 30 hp. It consists of a heavy-duty, induction-type motor, "Moreflex" coupling, double-packed type stuffing box with sealing ring, shaft, and propeller. The shaft and propeller are supplied in several types of corrosion resistant alloys. Motors are available in all enclosures and for all voltages. Eastern Industries, Inc.



More "What's New!" Items, p. 714

5—Pump Handles Volatiles

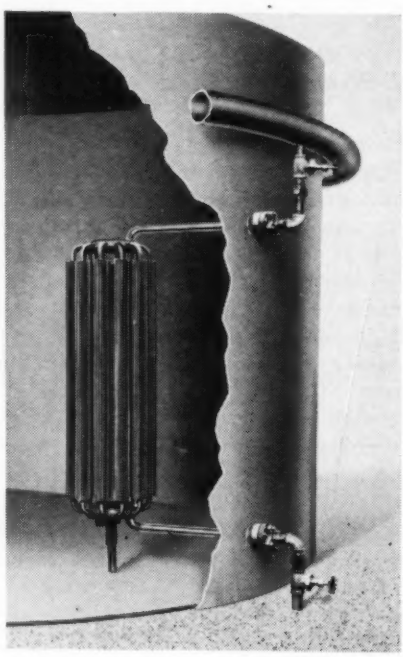


The new model "Tri-Rotor" pump is said to be especially applicable for handling such materials as aviation gasoline, naphtha, solvents, and similar fluids at differential pressures of 50 psi. and under. The pump may be equipped with solid, by-pass, or variable volume control type heads. All heads are interchangeable and are supplied with either iron or bronze fitted pumping members. A special alloy shuttle, complete with carbon bushing, is used to assure long, trouble-free life when handling clean, non-lubricating materials. Yale & Towne Mfg. Co.

6—Evaporometer for Solvents

The "Precision" — Shell Evaporometer was developed exclusively for the determination of evaporation rates of all solvents with a viscosity of less than 100 centipoises, and the solvent release characteristics of resin solutions. It is said to be of advantageous use in the petroleum and paint and varnish industries. An automatic filled microburet releases a sample on the filter paper cone suspended from a helical quartz spring and rotated by a motorized electromagnet to distribute the sample evenly. After the cone is "freed," the spring rises as the sample evaporates. Knobs on the outside of the case raise or lower the spring and cone assembly, the centimeter scale, and the mirror. When the sighting disc and its reflection are aligned with a scale calibration, an exact height reading is obtained. The case has an outlet for a timing mechanism, which can be operated by a switch on the panel. Volume of air drawn through the apparatus is indicated and controlled by an adjustable rotameter. Precision Scientific Co.

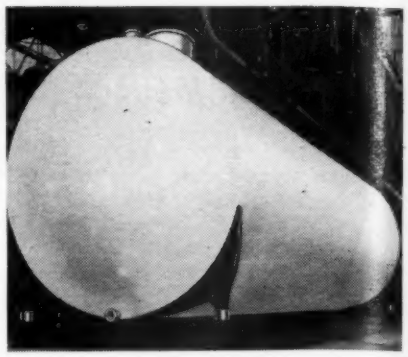
7—Efficient Tank Heater



A new vertical-type tank heater is said to be less expensive and more efficient than conventional horizontal types. Units are compact and will pass through a standard 20-in. manhole with ample clearance. The vertical mounting helps eliminate deposits in the tubes. Manufacturer states units can be removed easily from the tank, repaired or cleaned outside the tank; or a damaged heater can be quickly replaced with another from stock. Heaters can be installed in either new or existing tankage, and can be used singly or in groups. Brown Fintube Co.

8—Large Glass-lined Tanks

Glass lined chemical storage tanks in greatly increased sizes up to 35,000 gals. capacity are now available. The one-piece glass lined units are fully resistant to all acids at all concentrations except hydrofluoric and concentrated phosphoric acids. The 35,000 gal. tank shown measures 12 ft. in diameter by 45 ft. in length. The Pfaudler Co.

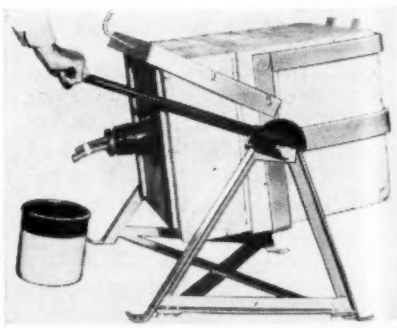


9—Glass Fiber Pipe Wrap

"Coromat" is a new, high-strength wrap for underground pipe lines, and consists of a porous mat of glass fibers reinforced with long, continuous strands of glass yarns. The high tear strength of the wrap (200 to 400% greater than the tear strength of the basic glass fiber wraps) is said to permit application at high speeds without breakage. Owens-Corning Fiberglas Corp.

10—Safe Carboy Tilter

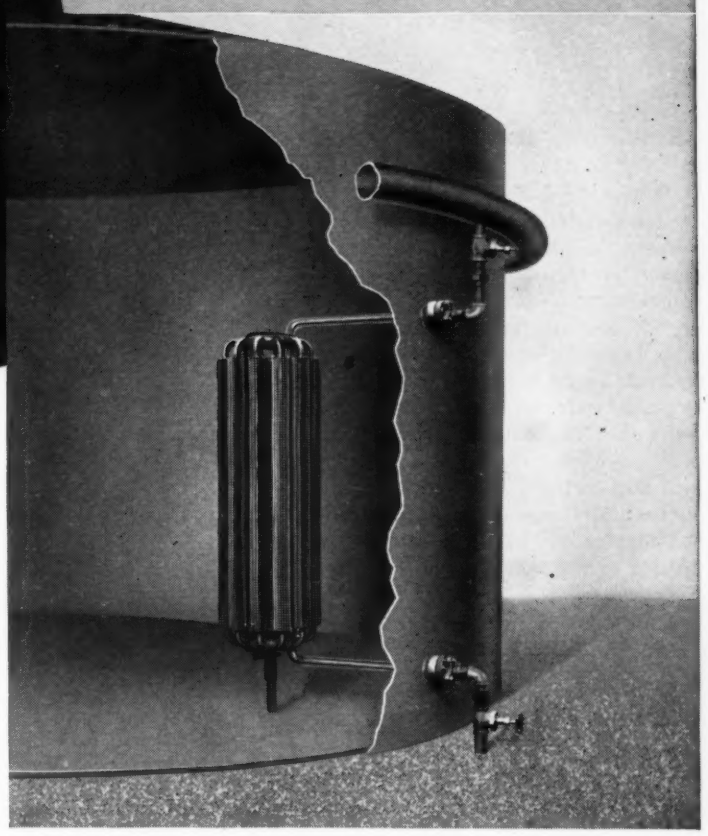
The new G-S Safety Carboy Tilter fits carboys of any size, and is constructed so that it can be left safely in a position just above the flow of the acid, eliminating the necessity of returning the carboy each time all the way to a pouring position. A locking device permits holding the carboy at any angle for one-man operation. A new safety air vent spout for pouring without spurts or splashes is made of acid resistant rubber and plastic tubing, and has a flow capacity of 5 gals. per min. Tilter and pouring spout—$34.50. General Scientific Equipment Co.



More "What's New!" Items, p. 716

THEY'RE *New -- Better, Cheaper and More Efficient*

BROWN FINTUBE *Thermo-Flo* TANK HEATERS



● Brown Fintube THERMO-FLO Tank Heaters are service proved — and offer many advantages as compared to the old method of using a bare pipe coil on the bottom of the tank.

EASY INSTALLATION—THERMO-FLO heaters are compact units. They will pass through a standard 20 inch manway with ample clearance.

REDUCED FOULING—The vertical mounting practically eliminates depositing on the tubes, and avoids the necessity of heating through a layer of sediment.

EFFICIENT HEAT TRANSFER — THERMO-FLO heaters set up a thermal siphon or "flow" within the tank, resulting in highly efficient heat transfer — and avoiding stratification.

LOW VOLUME DISPLACEMENT—Due to Brown's exclusive finned tube construction, each lineal foot of fintube in the THERMO-FLO heater has the surface equivalent of 6 lineal feet of plain bare pipe.

STURDY CONSTRUCTION — THERMO-FLO heaters are built to a standard design — in low cost production quantities — and are completely assembled and tested before shipment.

INEXPENSIVE—Users report that the cost of a group of Brown Fintube THERMO-FLO heaters — plus their installation — is *less* than just the installation of a bare pipe coil having equivalent heating capacity.

EASY MAINTENANCE—THERMO-FLO heaters can be removed from the tank easily and repaired or cleaned *outside* the tank,— or a damaged heater can be replaced with another standard heater from stock.

HIGHLY FLEXIBLE—THERMO-FLO heaters can be installed in new or existing tankage and additional units can be added to meet changing conditions.

MEET ANY REQUIREMENT—THERMO-FLO heaters can be installed singly or in groups. Fabricated from mild steel, stainless steel, monel, everdur, admiralty or other metals, to meet individual conditions.

Bulletin No. 491 Gives Full Details.
Write for a copy. Today!

THE BROWN FINTUBE CO.
ELYRIA, OHIO

FINTUBE HEAT TRANSFER PRODUCTS

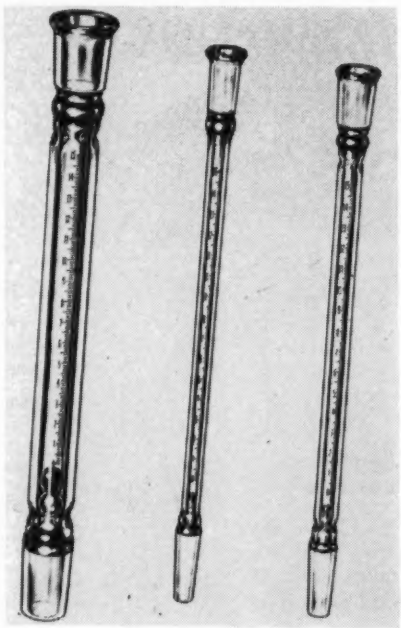
11—Air Ejection Pump

A new "SK Ejectopump" operates by compressed air at 30 to 50 psi. and is said to handle, without aeration, many liquids of varying viscosity at temperatures up to 120° F. and higher, depending on lift. Pumps have a maximum suction lift of 25 ft. and discharge heads up to 55 ft. Gritty and corrosive material can be pumped without damage to the equipment because there are no glands and no bearings. A rhythmic cycle of suction and discharge is maintained automatically by the air-operated ejector in the pump head. Schutte and Koerting Co.

12—Explosion-proof Controls

A new line of explosion-, dust-, and splash-proof controls has been added to the Coral Designs Co. standard static pressure controls. They are designed for hazardous locations in refineries, chemical plants, distilleries, grain elevators, and the like. Units are for very low pressures where regulation is required in in. of water pressure or vacuum. They are obtainable in standard ratings ranging from 0 to 20 in. of water, or vacuum with range adjustment, and with fixed and variable differentials of 0.2 to 2 in. water. They also are available with double throw circuits or floating contacts. Electrical ratings are approved by Underwriters' Laboratories for 10 amp., 125 v., or 5 amp., 250 v., A.C. Coral Designs.

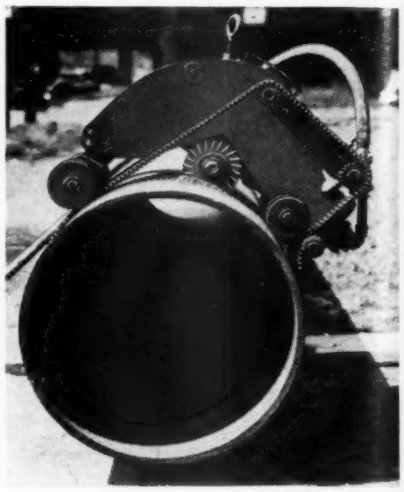
13—Laboratory Flowmeters



A rotameter-type set of laboratory flowmeters, comprising three instruments and each containing a glass and a stainless steel ball, provides for measuring a range of air flow from 3 to 110,000 cc./min., or a range of water flow from 0.064 to 3,800 cc/min. Instruments with a single glass ball also are available for those who require an all-glass construction because of corrosive conditions. Each instrument is supplied with a ground glass male and female outlet, and a complete set of calibration curves, and correction charts. Emil Greiner Co.

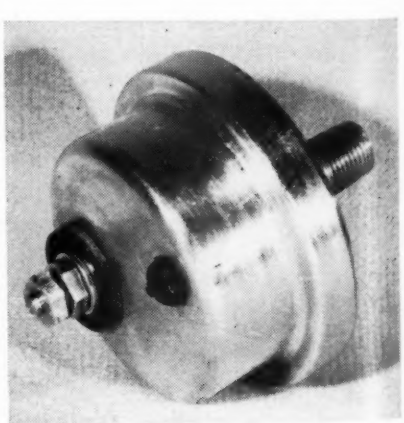
14—Air-operated Pipe Saw

The Wachs "National" Pipe Saw, operating by air power, will cut cast iron or steel pipe, from 12 to 48 in. in diameter at the rate of 2 in./minute. It uses a high-speed type steel milling cutter which leaves clean-cut milled edges and operates on 85 psi. air. Adjustments for different pipe sizes are made by setting guide rollers and altering the two travel-chain lengths. The saw is portable, weighing 265 lbs., and can be set up for work by two men in about 15 minutes. Underground cuts can be made with 14 in. clearance in the ditch. E. H. Wachs Co.



15—Accurate Pressure Switch

Close accuracy is said to be a feature of a new Auto-Lite diaphragm pressure switch, which will control contact at ±0.25 psi. The switch is designed to indicate pressures ranging from 10 to 25 psi. and will withstand up to 300 psi. with no effect on the beryllium copper diaphragm which is sealed with an "O" ring. Construction is such that there is a high ratio of travel at the breaking point, providing a wiping action on the contact points. The unit is designed to carry up to 5 amps. at 12 volts, AC or DC, and is made in two styles —single wire for grounded circuit and double wire for ungrounded circuit. It will be made available in other pressure ranges for individual applications. Electric Auto-Lite Co.



More "What's New!" Items, p. 717

What's New!

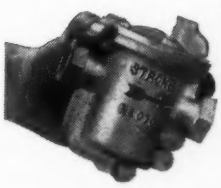
16—Petroleum Test Thermometers

Two newly developed testing thermometers are being offered to meet the specification of the API Code (25 and ASTM 58F-48T and 59F-48T) for crude oils. The 16¾ in. Cup Case thermometers are made in two ranges: −30 to +120° F., and 0 to +180° F. with a guaranteed accuracy of ± ½° F. The case is oak and treated to resist warping. Non-sparking, brass cup holds 100 cc. samples. The Armored thermometers are 12 in. long, with the etched stem thermometer encased in brass armor. Ranges are −30 to +120° F. and 0 to 180° F. Taylor Instrument Cos.

17—Preparative Centrifuge

The Model L "Spinco" Preparative Centrifuge applies forces up to 125,000 times *g* on 150 cc. of material, and 60,000 *g* on quantities ranging up to 1100 cc. The unit is of the vacuum-chamber type, with a two-stage mechanical pump creating a usable vacuum within 5 min. of starting. Housing is 25 by 30 by 36 in. Smallest rotor available is 6¾-in diameter, holds 150 cc. of material, and reaches terminal speed of 40,000 rpm. in less than 4 min.; largest is 11-in. diameter, holds over a liter, and reaches maximum speed of 20,000 rpm. in less than 20 min. Geared drive mechanism is electrically powered by a 1½-hp motor, which is ordinarily supplied for operation on 115/230-volt, 50 or 60 cycle power. Prices are approximately $3300 with refrigeration (for processing material at reduced temperatures), $3000 without. Specialized Instruments Corp.

More "What's New!" Items, P. 718



for small drainage jobs . . .

A NEW *SMALL* TRAP WITH *BIG* TRAP QUALITY FEATURES!

TEST
STRONG
OUTLET
INLET
DRAIN
• Renewable seat—easily removed for servicing.
• Strong's patented, wear-resistant Anum-Metl† valve and seat—guaranteed leak-proof for one year. Scientifically designed Hi-Cap* orifice gives greater capacity.
• Oversized ports—increased capacity.
• Horizontal inline connections—simplifies piping.
• Stainless 18-8 high ratio leverage.
• Large gasket area.
• Seamless, deep drawn, stainless 18-8 bucket—no welds.
• Bottom drain or inlet connection.

Available for pressures from 0 to 150 p.s.i., the Strong* No. 070 fits all standard trap applications. Built especially for use on laundry, restaurant and hospital equipment and in industry wherever small drainage is a problem.

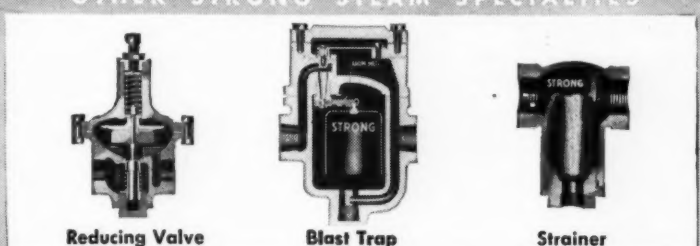
As with all Strong Semi-Steel Traps, the 070 is guaranteed against defects in material and workmanship for one year. Write today *for more complete information.*

*T. M. Reg. U. S. Pat. Off.

STRONG, CARLISLE & HAMMOND COMPANY
1392 West 3rd Street
Cleveland 13, Ohio

† ANUM-METL Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES



STRONG

Buffalo TANKS

Serving the Petroleum and Process Industries

OIL AND GAS TANKS
PRESSURE VESSELS
WELDED STEEL PLATE CONSTRUCTION

BUFFALO TANK CORPORATION

General Sales Office
744 Broad St., Newark 2, N. J.

PLANTS
Buffalo, N. Y.
Baltimore, Md.
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NEW!

LIQUID LEVEL CONTROL AND AUTOMATIC CUT-OFF

MAGNESWITCH

Here is the new Magneswitch Type H magnetic proximity float switch that gives you more dependable, more accurate control with less maintenance. For high and low stage alarm, limit switches, intake and suction scrubbers, etc. Standard controls for pressures from vacuum to 600 psi.

Check these advantages!

- No Packing Boxes, Bellows, or Diaphragms
- Forged Steel Body
- No False Action Due To Turbulence
- Standard or Explosion Proof Cover
- Mechanism Isolated from Corrosive Fluids

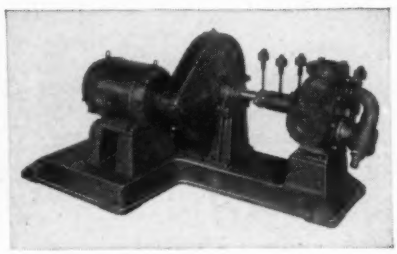
WRITE TODAY FOR FULL DESCRIPTIVE INFORMATION

JO-BELL PRODUCTS, INC.
4840 So. St. Louis Ave., Chicago, Ill.

What's New!

18—Fast Unloading Pumps

A new 200 gpm. positive displacement pump has been designed to speed up loading or unloading of fuel oil, gasoline, or Diesel fuel. It is totally enclosed, as is the motor and gearing, thus permitting operation of the unit outdoors without any protection. Optional valve on pump head is designed to prevent damage if discharge line is closed. Viking Pump Co.



19—Calculating Service

A new engineering computing service, employing automatic electronic calculating machines, punched card forms, and other modern equipment for high-speed engineering analysis work now is available to a wide variety of industries who want to reduce overhead and release scientific and technical talent from routine calculations for full time devotion to creative work. Special equipment has been developed and put to use for reading data from graphs, film, or tape records. Fields covered include structure, electronics, chemistry, physics, hydraulics, production study, statistical analysis, and the like. Telecomputing Corp.

20—Plastic Skylights, Windows

"Alsynite" is a new light-weight—8 oz/sq. ft. — translucent material which can be substituted for conventional glass in skylights and windows and eliminates the need for heavy and costly framework. It consists of sheets of "Fiberglas" mat, impregnated with "Laminac" resin, and is corrugated similar to corrugated metal sheets. It can be sawed, nailed, punched, drilled, and fastened in place with ordinary sheet metal screws, or bolts. With flat corrugations, sheets 26-in. wide are available in 8 to 10 ft. lengths. It can also be supplied with curved corrugation for Quonset applications. Owens-Corning Fiberglas Corp.

More "What's New!" Items, p. 719

AMMONIA
(Refrigeration Grade)

TANK CARS and CYLINDERS

direct service from producing point to user available on contract shipments or spot orders from...

SPENCER

SPENCER CHEMICAL COMPANY
Executive and Sales Offices
613 Dwight Building
Kansas City 6, Missouri

CONTACT SPENCER NOW FOR YOUR AMMONIA NEEDS

What's New!

21—Technical Information Service

Current information of a technical and economic nature on petroleum refining and related fields is now being offered in "The Monthly Summary of Industrial Developments Related to Petroleum Processing," the first issue of which was published May 2, 1949. The summary will be published during the first week of each month and constitutes a survey of interesting literature in one daily, 17 monthly, and seven weekly periodicals in their coverage of the petroleum processing field. It is being published by the Technical Information Division of the Georgia Tech Engineering Experiment Station, under the editorship of Ben H. Weil, chief of the Division. The bulletin is available to any individual, company, or library only on a full participating sponsorship basis, with the sponsor designating the number of copies he needs. Mr. Weil, prior to joining Georgia Tech, was for five years chief of the Information Section of the Gulf Research & Development Co.'s Chemistry Division. The author of several books and articles on petroleum chemicals, plastics, synthetic liquid fuels, etc., he has served as editor of PETROLEUM PROCESSING's "Tomorrow in Petroleum Technology" since its inception. Georgia Institute of Technology.

Trade Literature

22—Bubble Tray Research

The Kelloggram, Issue 2, 1949: describes in pictures and text how a transparent, Lucite-constructed experimental model of a bubble tower has aided in research on tray efficiencies, new design, and the like. M. W. Kellogg Co.

23—Surge Control in Piping

Bouncing Pipes, Engineering Bulletin No. 121, explains in lay language and with cartoon-style diagrams the physical mechanisms involved in the control of surge pulsations in gas and air piping. Burgess-Manning Co.

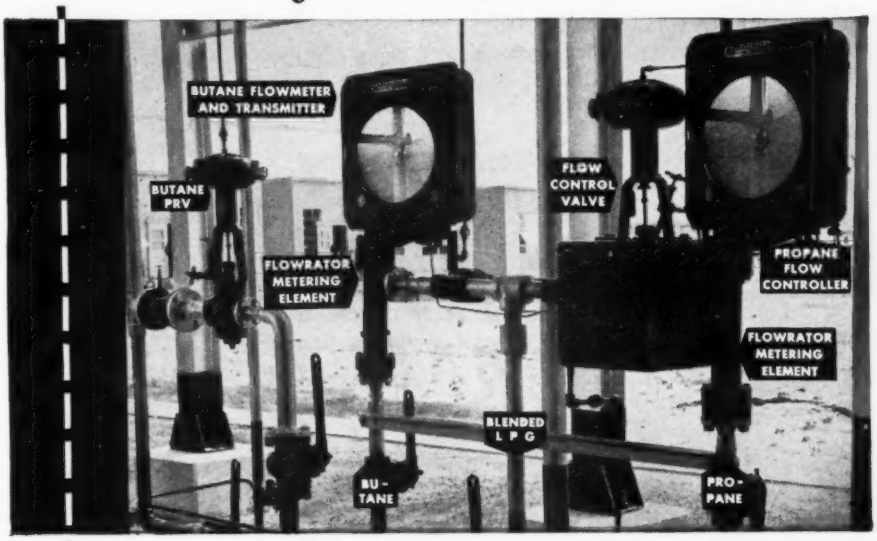
24—Expansion Joints

CMH Expansion Joints, Bulletin EJ-49; eight pages covering sizes, specifications, and other information on both "Free-Flexing" and "Controlled Flexing" corrugated type expansion joints in copper and stainless steel construction. Chicago Metal Hose Corp.

More "What's News!" Items, p. 720

LPG BLENDED MORE PROFITABLY AND MORE UNIFORMLY

through simplified straight-line accuracy flow control



The F & P RATIO CONTROLLER blends overhead products from depropanizer and debutanizer columns to exact vapor pressure specifications. It's no longer necessary to change tower operation when vapor pressure specs are altered; you simply turn a knob in the RATIO CONTROLLER to get any blend ratio between 90% C3 - 10% C4 and 10% C3 - 90% C4.

The flow of butane is accurately measured by a FLOWRATOR meter-transmitter. This resets the control point on a similar FLOWRATOR instrument which controls the amount of propane put into the LPG mixture.

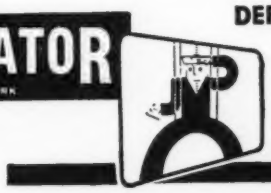
Here are a few of the "plus" features of the F & P RATIO CONTROLLER:

1) They record butane and propane flows; valuable operating records are produced without additional flowmeters. 2) Their flow scales are uniformly spaced; peak accuracy is assured over the entire range of flow measurement. 3) They are free of electrical connections; safe in hazardous areas. 4) They require no "meter runs"; installation cost are low. 5) There is just one moving part, free of packing glands; maintenance costs are negligible.

For detailed engineering information write for Bulletin 53.

FISCHER & PORTER CO.
DEPT. 9R-1Z HATBORO, PA.

FLOWRATOR TRADE MARK



INSTRUMENTS FOR FLOW MEASUREMENT AND AUTOMATIC CONTROL

25—Reaction Vessels

Pfaudler "R" Series Reaction Kettles, Bulletin 860; 14 page booklet giving specifications on standard and custom-built, high pressure, glass-lined, steel reaction kettles, auxiliaries, fittings, and accessories. The Pfaudler Co.

26—Rapid-acting Transmitter

Taylor Technology, Vol. 1, No. 4, Spring, 1949: includes a technical article on the new "Transaire" Temperature Transmitter, a fast-response, pneumatic force-balance instrument, providing a derivative action which compensates for poor process heat transfer and lags introduced by separable wells. Taylor Instrument Cos.

27—Pipe Tool Catalog

Toledo Pipe Tools Catalog; a 52-page catalog covering hand-operated tools in capacities up to 12-in. pipe; power machines in three models for ½ to 4-in. pipe; power drives in three models for geared pipe threaders; supplies and accessory equipment. Toledo Pipe Threading Machine Co.

28—Perco Processes Explained

Pointing the Way to Profits with Perco Processes; Bulletin 163; 28 page brochure describing the Perco processes including cycloversion, polymerization, dehydrogenation, gas reversion, HF alkylation, copper sweetening, superfractionation. Phillips Petroleum Co., Perco Division.

29—Oil Company Research

Atlantic Research at Work; a 28-page booklet telling in words and pictures how one petroleum company conducts its various research programs. Atlantic Refining Co.

30—Pipe Joint Data

Gaco Pipe Joint—Engineering Data: a brochure giving engineering specifications and sizes for the new rubber lined Gaco pipe joint, and fittings, available in nominal pipe sizes from 1½ in. to 10 in. (The pipe joint was reviewed in "What's New!" February, 1949, No. 4). Gates Engineering Co.

31—Protective Coatings

"Perma-Skin" Vinyl Corrosion Resistant Protective Coatings: a 4-page folder describing a system for protecting metal, wood, stone, brick and concrete structures against corrosion by atmospheric and chemical action. Dennis Chemical Co.

32—Liquid-liquid Extraction

Centrifugal Liquid-Liquid Extraction Overcomes Emulsifying Tendency: a reprint from Chemical Processing Preview, describing the application of pressure-tight, centrifugal, multi-stage extractors to the solvent extraction of penicillin broth. Podbielniak, Inc.

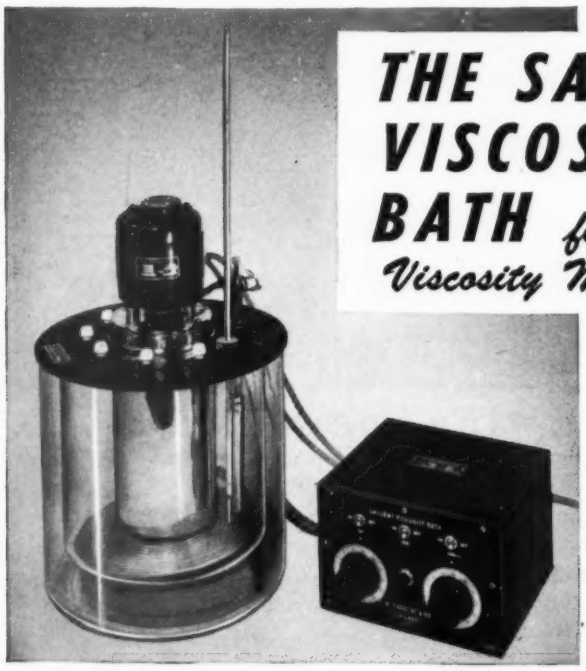
33—Communication Systems

New Code Call Systems, Bulletin 4B-269: 6-page folder describing operating features of a new 20-station call unit for locating personnel not at their customary locations. Signal Engineering & Manufacturing Co.

34—Welding Supplies

Gas Welding Supplies, Catalog 12: 16 pages on Airco's rods, fluxes and other gas welding supplies. Gives descriptions of mechanical properties and recommendations regarding application. Air Reduction Sales Co.

More "What's News!"Items, p. 721



THE SARGENT VISCOSIMETER BATH *for Kinematic Viscosity Measurements*

The Sargent viscosimeter bath has been in general use, in its essential form for more than ten years and because of the soundness of its design, the present stock differs only in minor refinements from the original models.

Precision of automatic temperature control in the Sargent bath is actually, at least as good as its rating of ±0.02° F. and in order to attain this degree of efficiency we believe an oil bath must have the following essential factors.

1. **Lagless heaters** formed of heavy gauge chromel helices directly exposed to the oil.
2. **A high rate of circulation** using directed turbine flow.
3. **Variable input** to the permanent and intermittent heaters, such that the steady heat supply can be set to compensate the greater part of the steady rate of heat loss, leaving a minimum wattage to be applied by the intermittent heater, as the cyclic correctional increment.
4. **Double walled container.**
5. **Thermoregulator** of the maximum sensitivity compatible with serviceability characteristics.

The proper balance of these factors makes the Sargent viscosimeter bath the only bath which we are certain is capable of the rated precision when using oil as the bath medium and operating in the vicinity of 210° F.

Specifications:

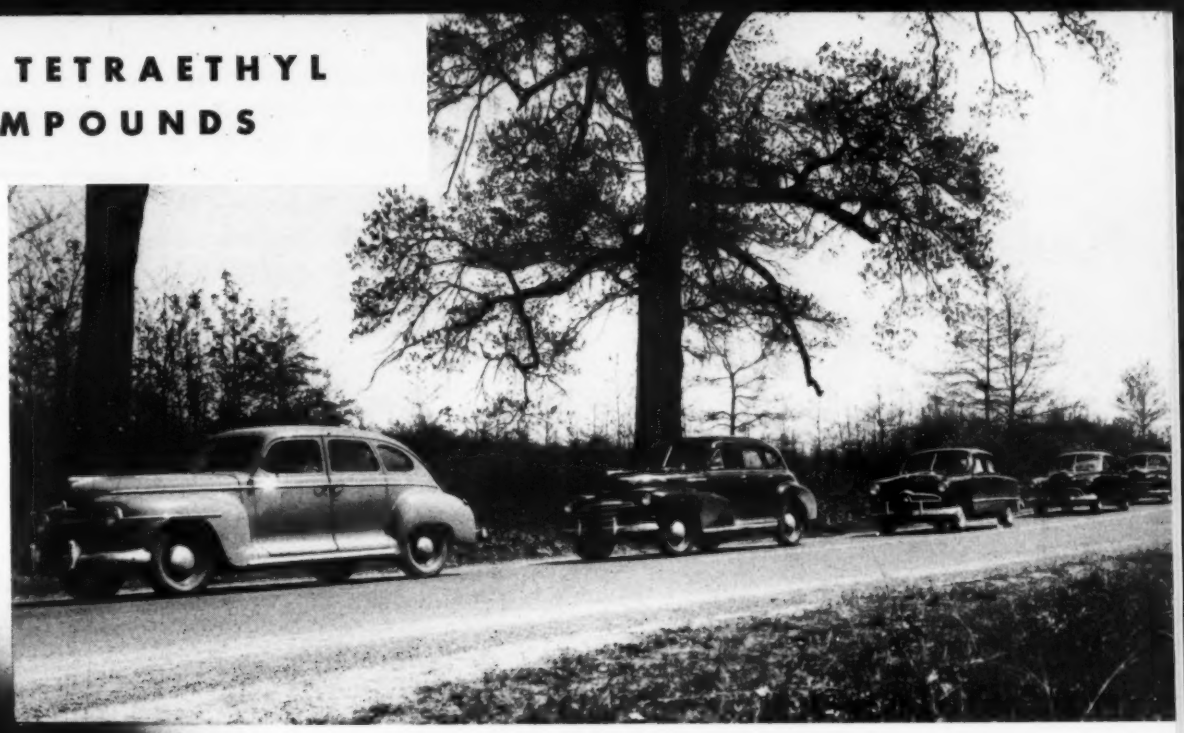
Range: to 210° F.
Dimensions: Inner jar diameter 10", depth 10"
Outer jar diameter 12", depth 12"
Precision: 0.02° F.
Maximum Power Consumption: 1200 watts.

S-83255 VISCOSIMETER BATH—Oil, Constant Temperature High Precision 0.02° F., Sargent (Patent No. 2,037,995). As described, for use from 115 volt 50/60 cycle A.C. circuits..... **$230.00**

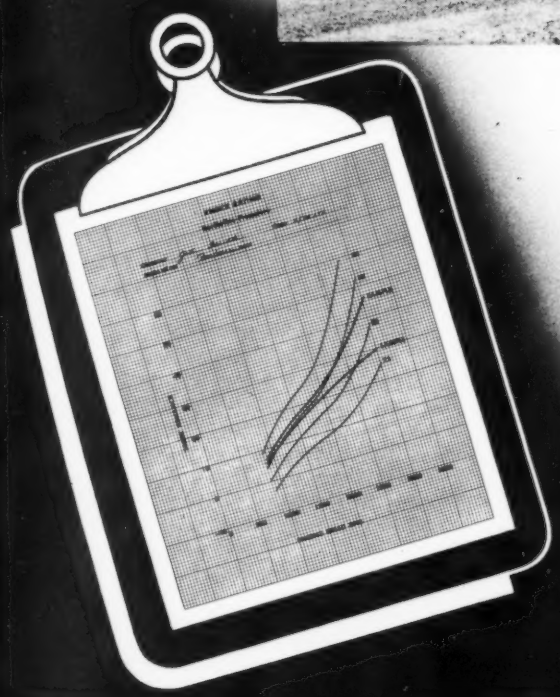
SARGENT

SCIENTIFIC LABORATORY EQUIPMENT AND CHEMICALS
E. H. SARGENT & COMPANY, 155-165 EAST SUPERIOR ST., CHICAGO 11, ILL.
MICHIGAN DIVISION 1959 EAST JEFFERSON DETROIT 7, MICHIGAN
SOUTHWESTERN DIVISION 5915 PEELER ST. DALLAS 9, TEXAS

DU PONT TETRAETHYL LEAD COMPOUNDS



Fleet of antiknock rating cars from the East Coast Road Test Laboratory enroute to testing area.



Du Pont Research

Road Testing for Fuel Performance

Combustion knock is one of the most important factors limiting development of improved engines. While laboratory test methods provide a measure of fuel knocking characteristics, the final criterion of a fuel's worth is its performance in a car on the road. For that reason, road testing plays an important part in the Du Pont research program on tetraethyl lead and other antiknock agents.

To provide a complete evaluation of fuels and additives under a wide variety of road conditions, Du Pont maintains road testing facilities on both the East and West Coasts. Cars of the East Coast Laboratory weekly roll up thousands of miles studying fuel performance in both stock passenger cars and cars equipped with experimental high compression ratio engines.

The Road Test Laboratory is used by Du Pont to evaluate motor car fuel needs and to proof-test the experimental additives which come from chemical research. This is research aimed at helping you produce better fuels—today and in the future.

Drivers compare notes between test runs.

DU PONT
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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMIST*

Measuring

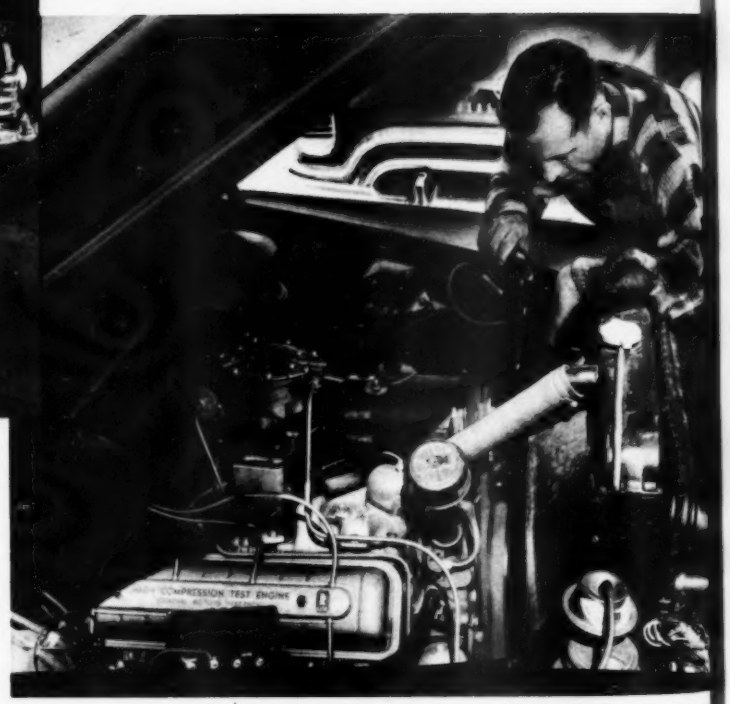
Fuel Performance in Today's and Tomorrow's Engines

It is well known that fuels of different chemical types have markedly different "octane numbers" under different engine conditions. When compared with laboratory ratings, some fuels appreciate in octane value on the road while others depreciate. The numerous factors affecting fuel performance such as operating conditions, vehicle and engine design and many others are being investigated by the East Coast Laboratory through extensive road anti-knock and endurance testing.

Another project is an investigation of the effect of experimental high compression ratio research engines on fuel performance. These are installed in test cars and are being used in the study of fuel requirements.

Information developed through road testing will contribute to improved additives and fuels, today and in the future.

For comparative service and endurance tests on fuels identical cars are used. Here a group is being serviced prior to a run.



In addition to stock passenger cars, cars equipped with experimental high compression ratio research engines are used to study fuel performance. This 10 to 1 ratio engine is being checked during a road test.

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Tetraethyl Lead Compounds
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Antioxidants
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What's New!

35—New Design in Fittings

New Main Line Fittings for Gas Transmission Systems, Bulletin 492: describes in question and answer form a unique new design in compound ells, the "Compound Tanj-Ell", which provides virtually any angle needed in laying, say a field gathering system, without heavy bending equipment needed. Includes specification tables on the fittings in sizes from 8⅝ to 36 in. O. D. Taylor Forge & Pipe Works, Inc.

36—Valve Prices Reduced

Errata Sheet—Catalog No. 48; and *Bulletin* 48-105*A*: covering price reductions of about 10% on Farris Safety and Relief Valves, effective May 9, 1949. Farris Engineering Corp.

37—Tank Capacity Calculator

Hammond Tank Capacity-Size Calculator: a pocket slide rule for calculating the capacity (in gallons, cubic feet, or 42-gal. barrels) of vertical tanks; also gives decimal equivalents of a foot for inches from 0 to 12 by eighths. Hammond Iron Works.

38—Synthetic Fuel Instrumentation

Instrumentation for Coal Hydrogenation Processing: a 20-page booklet describing, with diagrams, the instrumentation at the Bureau of Mines demonstration plant at Louisiana, Mo. Minneapolis-Honeywell Regulator Co., Brown Instruments Div.

39—All-chemical Lube Additive

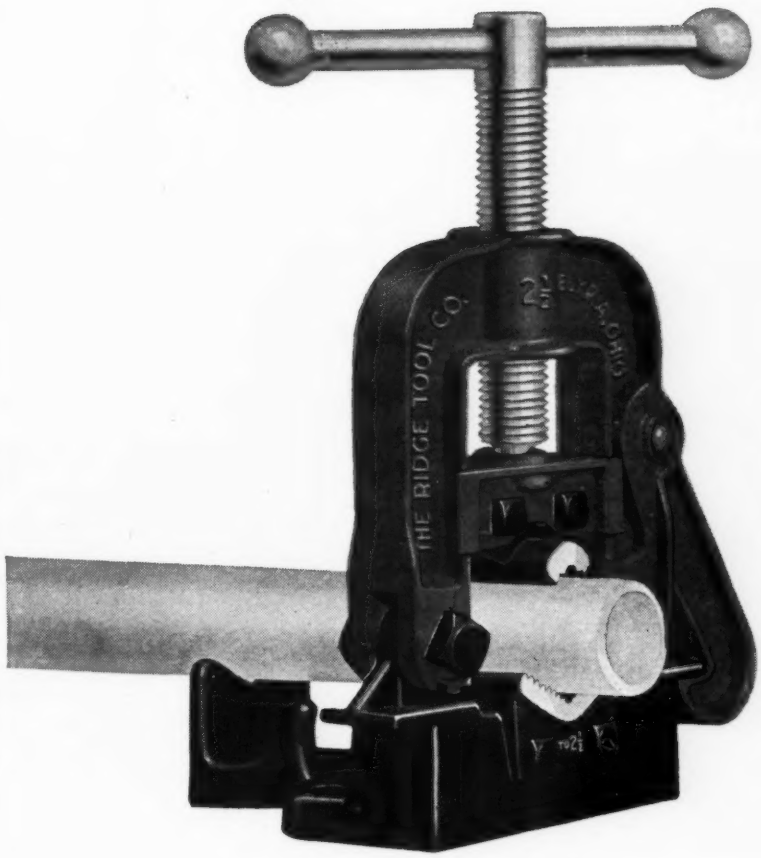
Aerolube 70, a new all-chemical additive for crankcase lubricants, is described as an oxidation and bearing corrosion inhibitor requiring a minimum amount of storage space because no diluent oil is needed; the material has complete solubility in oil, stability, and compatability with other additives. American Cyanamid Co.

For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 713. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

THIS BENCH PIPE VISE

Saves your Time



RIDGID Pipe Vises are equipped with handy pipe rests and benders . . .

● RIDGID bench vises make your work extra easy, fast, efficient. Integral pipe rests support pipe firmly. Handy built-in benders won't mar or flatten pipe. LonGrip jaws of heat-treated tool-steel have bulldog grip but are easy on polished pipe or tubing. 8 sizes for pipe to 6." RIDGID bench, post, stand and Tristand vises, yoke and chain types . . . give you more for your money. Buy them at your Supply House.

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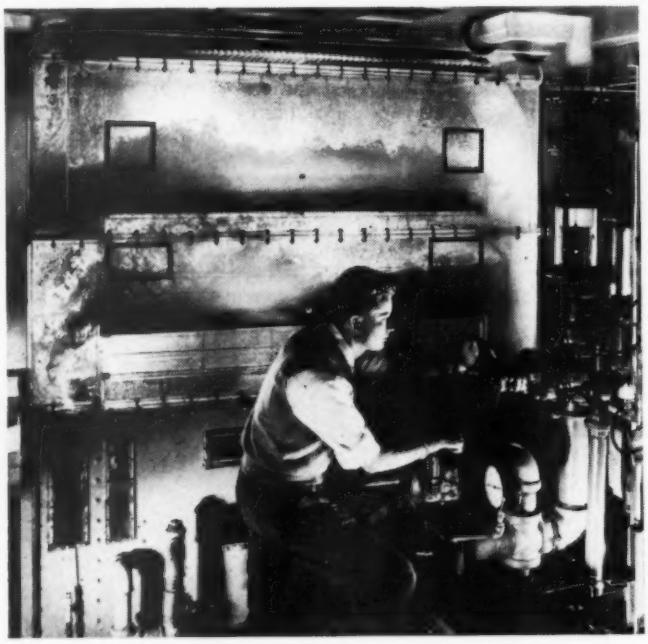
NEWS OF

Manufacturers—Suppliers—Engineering Firms

Serving the Petroleum Processing Industry

Bubble Trays Studied Visually At Kellogg's Laboratories



Visual research on bubble trays by Kellogg

Bubble tower research of the visual type, initiated by M. W. Kellogg Co. as far back as 1935, has been made more flexible by use of a transparent, Lucite plastic unit. The stroboscopic photograph of the unit in action shows artificial induction of severe dumping at the right half of the lower tray and excessive entrainment above left half. Droplets in left half are so violently agitated by vapor that they are running countercurrent to the flow across the plate.

Although this may cause good mixing, the lack of bubbling and consequent dumping at the right create a serious loss in efficiency.

The latest *Kelloggram,* Issue 2, 1949, carries a complete story on the company's bubble tray experiments. Readers desiring a copy are requested to circle No. 22 on the "What's New!" reply card facing page 713.

New Houston Engineering Firm

The Wyatt C. Hedrick Engineering Corp., a new enterprise formed by Wyatt C. Hedrick, Houston architect and engineer, will specialize in the planning and construction of plants for the petroleum, natural gas, chemical, and allied industries.

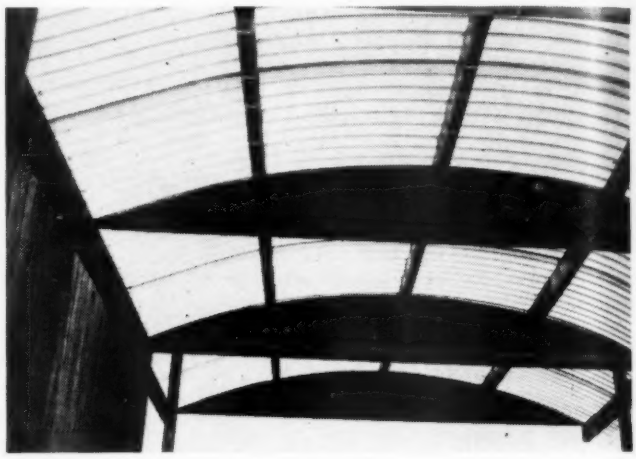
Heading the company is G. M. McGranahan, formerly assistant general manager of Dow Chemical Co.'s Texas Division, and more recently vice president and general manager of the McCarthy Chemical Co. Other officers include H. H. Bowen, vice president; Robert H. Gaddy, secretary; and Hedrick as vice president and treasurer. Mr. Bowen also has been connected with both Dow and McCarthy. General offices will be maintained in Houston.

Republic Holds Three-day Open House

Over 5000 oil industry leaders in the California area attended the recent three-day open house in the new modern headquarters of Republic Supply Co. of California, 2600 So. Eastland Ave., Los Angeles 5. Guests were given an informal tour through the 23,000 sq. ft. office and the 90,000 sq. ft. warehouse.

Skyrm Up at General American

Harold D. Skyrm has been elected vice president of General American Transportation Co. at its annual meeting, it has been announced by Sam Laud, president. Mr. Skyrm, who has been associated with General American for many years in several capacities, was recently made head of the Process Equipment, Plate & Welding, and Wiggins Vapor Seals Divisions, with offices in Chicago.



Above: Translucent skylight sheets of plastic and Fiberglas fastened to steel rafters in covered entrance to National Tank's new mill building

National Tank Completes New Plant, Uses Unique Plastic Skylights

National Tank Co., Tulsa, has just completed a new plant, adding 240,000 sq. ft. to its shops area, on a recently acquired 36½-acre tract across the road from the "old" plant, which has a working floor area of 5000 sq. ft.

The new facilities are divided into 10 major departments. All are served by heavy-duty overhead cranes in the 5 to 10-ton class, some on trolleys. The separator assembly bay includes a 2000° F. stress-relieving furnace, 7 x 7 x 40 ft. A larger furnace for the same purpose is located in the heavy welding bay. The latter measures 15 x 15 x 80 ft., and can handle vessels 12 ft. in diameter, and any length, and shell thicknesses up to 2 in.

A feature of the windows and roof skylights in the plant is the use of a new light-weight material instead of conventional glass, thus eliminating the need for expensive framework usually required. Known as "Alsynite," the material consists of translucent sheets of "Fiberglas" mat impregnated with "Laminac" resin, and weighs about 8 oz./sq. ft. Corrugated in a manner similar to corrugated metal sheets, it can be sawed, nailed, punched, or drilled, and fastened in place with ordinary sheet metal screws or bolts. For weatherproofing lap joints, a translucent mastic is available. (See "What's New!" section this issue, Item No. 20.)

Bottomley Is TRECO Vice President

Harold Bottomley, formerly chief process engineer for the Refinery Engineering Co. of Tulsa, has been

RAISE THE RESEARCH OCTANE RATING OF YOUR CONDENSATE GASOLINES

with

PERCO CYCLOVERSION CATALYTIC REFORMING

Cycling plant or condensate gasolines can be upgraded in both Research and Motor Octane values with an economical, efficient PERCO Cycloversion Catalytic Reforming Unit in your plant.

Full scale commercial PERCO operations on cycling plant or condensate stocks are meeting with complete success. Research octane ratings are being raised as much as ten numbers at the 3 cc TEL level with high yields. Catalyst cost is extremely low — actually only a fraction of a cent per barrel.

Install a Perco Cycloversion Catalytic Reforming Unit, the plant that has already been proved by actual construction and operating experience.

Considerable flexibility in processing conditions is possible with Perco Cycloversion Catalytic Reforming to meet varying product specifications. A Perco engineer will gladly explain more fully the benefits you may expect from a Perco application to your cycling plant or condensate stocks.

Write for our latest 28 page brochure, "Pointing the Way to Profits with Perco Processes."

Phillips 66

PERCO PROCESSES

PROFIT WITH PERCO PROCESSES

PHILLIPS PETROLEUM COMPANY

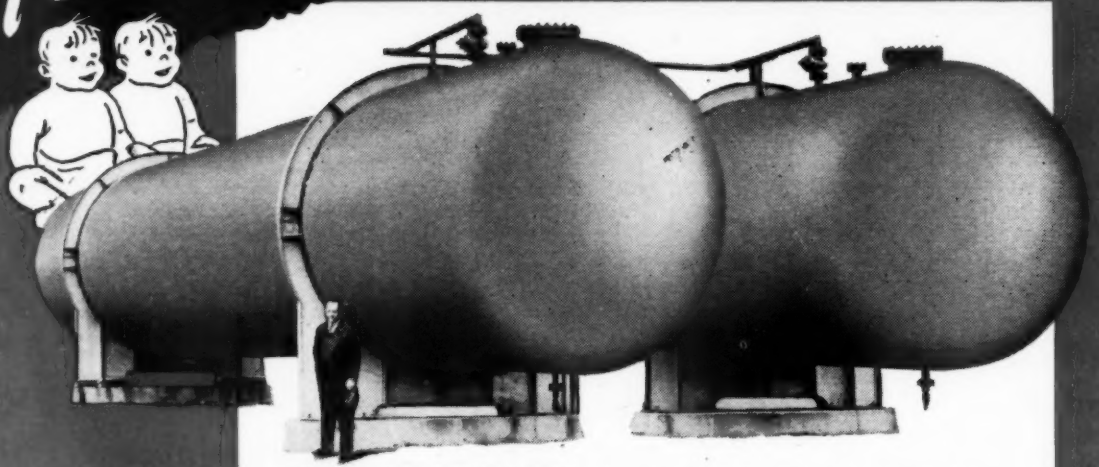
CHEMICAL PRODUCTS DEPARTMENT

PERCO DIVISION

BARTLESVILLE, OKLAHOMA

Twins

Sound POSEY Construction
Sensible POSEY Estimates



The TWIN TANKS shown are two more examples of the twin *advantages* Posey offers users of gas storage equipment: (1) sound Posey construction (2) sensible Posey estimates.

Posey shop practice eliminates many "rule-of-thumb" methods . . . many outworn fetishes . . . that do nothing to improve tank quality, but do a great deal to increase tank costs. Yet Posey omits *NO* practice that makes for dependable, pressure-resistant installations. Posey tanks are expertly designed with liberal allowances for safety factors. Physical and chemical analyses of steels used are gladly furnished to customers upon request. Strict X-ray inspection assures faultless welding. Tanks are "custom-built" to specifications in all sizes up to 30,000 water gallons.

Posey tanks are fabricated in strict accordance with standard codes . . . minimize hazards . . . meet insurance requirements . . . reduce maintenance. Posey is equipped to do the *complete* job . . . from initial design to fabrication to final erection. Write today for full details. No obligation.

Established Since 1910

***New York Office:* Graybar Building**

POSEY IRON WORKS, INC.

formerly LANCASTER IRON WORKS, INC.

LANCASTER, PENNA., U.S.A.

DIVISIONS: Steel Plate • Asphalt • Steel Form • Brick Machinery

appointed a vice president, according to President T. M. Lumly. Mr. Bottomley joined TRECO in 1947 after having served in various engineering capacities with Republic Oil Refining Co., Cities Service Oil Co., Cosden, Kanotex, and Shell. In his new position, he will devote a greater portion of his duties to contacting the company's clients in widely scattered sections of the country.

Griscom-Russell Executive Changes

Russell C. Jones, president of Griscom-Russell Co. since 1939 and associated with the company for 40 years, retired as president on April 30, but will continue as a director. Kenneth B. Ris, previously vice president in charge of sales, has been elected to succeed Mr. Jones. At the same meeting, the Board of Directors elevated Charles D. Steffens from sales manager to vice president—sales. James W. Elizardi was elected vice president—petroleum sales, reporting to Mr. Steffens.

Mr. Jones originated many of Griscom-Russell designs of heat transfer apparatus, and played a leading role in guiding the expansion of the company's products into the petroleum refining, utilities, and chemical process industries.

Lukens Steel Staff Promotions

Three promotions on the staff of Lukens Steel Co., Coatesville, Pa., have been announced by Lester M. Curtiss, general works manager. Harry A. Fohl has been named chief engineer; Neils H. Jensen, assistant chief engineer; and Malcolm B. Antrim, superintendent of electrical maintenance.

P. C. Haldeman, who has been chief engineer since 1932, and Walter H. Burr, who has been superintendent of electrical maintenance since 1921, will retire July 1, each having reached the age of 70 years.

American Cyanamid Appointments

The recently formed new product development department of American Cyanamid Co. announces the appointments of Dr. James R. Dudley as supervisor of new product development and John D. McPherson as supervisor of market research activities.

Dr. Dudley, a graduate of Carleton College in 1936 and holding his advanced degrees from the University of Iowa, joined the company in 1940 as a research chemist at the Stamford laboratories.

Mr. McPherson joined the company in December, 1945, after his release from the Chemical Warfare Service of the U. S. Army, with the rank of Lieut. Colonel.

Insulation Manual Published

A 96-page manual on 85% Magnesia insulation is being published by the Magnesia Insulation Manufacturers Association and will be made available in July to those individuals who have a direct interest in industrial heat insulation.

Among the subjects covered are: properties, determination of correct thicknesses, application and finishing procedures, and maintenance. The appendix will contain a discussion of practical applications of heat transmission theory, definitions of technical terms, data tables, a glossary of trade terms, and a list of trade names.

Requests for copies should be made to the Association at 1317 F Street, N. W., Washington 4, D. C., on business letterhead, giving the title of the individual making the request.

Expansion and Transition

Dow Chemical Co. has transferred to its subsidiary, **Dowell, Inc.**, Tulsa, the marketing of its magnesium anodes, "Galvo-Pak" and "Galvo-Line" for control of underground corrosion.

Fritz W. Glitsch & Sons, Inc. have recently moved into a new plant at 4800 Singleton Blvd., Dallas. The

Building

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Accurately On the Spot

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main manufacturing building, 270 x 400 ft., will contain fabricating facilities devoted to the making of carbon and alloy steel trays and caps, tower internals, and pressure vessels for the petroleum and chemical industries. It is estimated that the new arrangement will handle more than four times the old plant output.

Magneswitch, Inc. has announced that effective May 1, 1949, its name will be **Jo-Bell Products, Inc.** Address is now 4840 South St. Louis Ave., Chicago 32, Ill.

Walsh Refractories Corp. has announced the occupancy on or about June 1 of its new general offices at 101 Ferry St., St. Louis 7, Mo., conveniently adjacent to the St. Louis plant at 4070 N. First St.

New Branches and Distributors

Kieley & Mueller Inc., North Bergen, N. J., has announced three new sales representative appointments. John G. Kirkpatrick, 4405 Schenley Farms Terrace, Pittsburgh 13, Pa., will cover the tri-state area of Pennsylvania, New Jersey, and New York. Mr. Kirkpatrick has been in sales for four years with the Bristol Co. and one year with Fischer & Porter Co., as well as seven years as instrument engineer with Koppers Co. at its Kobuta, Pa., plant.

The Van Hala Industrial Sales Co., 1051 Power Ave., Cleveland 14, Ohio, will be an exclusive K & M sales representative in the Cleveland area. Henry A. Van Hala, head of the firm, formerly was Cleveland district manager for the Bristol Co.

Eggelhof Engineers, of Dallas and Houston, has established a new office in Corpus Christi, with Gordon R. Catts Jr., as division sales engineer in charge.

Air Reduction Co. has established a new warehouse point in Tulsa, at Fidelity Transfer & Storage Co., 1540 East Fifth St.

Other Personnel Changes

Kennedy Valve Mfg. Co.—J. Lawrence Kennedy has been appointed assistant to the president, in which capacity he will direct the advertising and sales promotion activities.

Schutte & Koerting Co.—Frederick L. Seibold has been named sales manager and Frederick Boehm has been appointed chief engineer.

Hooker Electrochemical Co.—William F. Goerge, New York district sales supervisor since 1942, has been made sales manager in that district. He will continue to headquarter at the New York office, 60 East 42nd St.

Peabody Engrg. Corp. — A. P. Olches, with the company since 1928, has been appointed chief engineer. He entered Peabody's employ as a sales engineer, and advanced rapidly to sales manager and then manager of research and development.

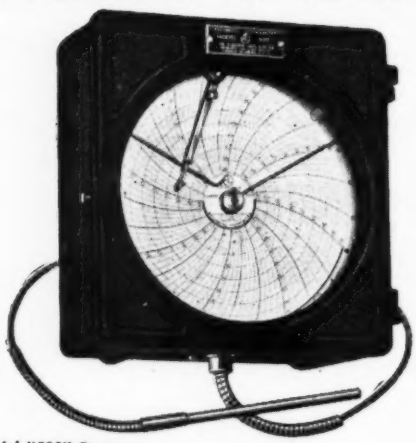
Fluor Corp.—Jack E. McKay, after three years as assistant to the vice president and director of sales, has been appointed manager of advertising and public relations, with headquarters in Los Angeles. Before joining Fluor in 1942, Mr. McKay was associated with Carter Oil Co. at Tulsa, and Sinclair Refining Co., Sand Springs, Okla.

Brown Fintube Co.—Laurence C. Johnston has been appointed district sales manager, with headquarters in New York City. Engaged in the heat transfer field for the past 15 years, Mr. Johnston previously was eastern district manager for Process Engineering, Inc., and also chief engineer of the Patterson-Kelley Co., Inc.

Depend on

AUTO-LITE

FOR TEMPERATURE RECORDING



Model "500" Recording Thermometer. Priced from $37.50

The low-priced Recorder shown above is precision-engineered for accuracy. Liquid-filled movement is responsive to changes throughout the temperature range. Legible 6" chart with wide selection of chart ranges between minus 40°F. and plus 550°F. Choice of 24 hr. or 7 day movement. Send for catalog showing this and many other types of Auto-Lite Thermometers.

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AER-O-FOAM
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Every batch of National Aer-O-Foam is fire-tested and fire-safe for quick, reliable protection against flammable liquid fires. Refineries, tank farms, bulk plants and storage terminals can rely on National Aer-O-Foam's sure, fast action. In a matter of seconds, Aer-O-Foam spreads freely to cover fires with its thick, tough, airtight blanket. It snuffs out the flames . . . lasts to keep them out . . . prevents reignition.
Non-corrosive, it clings to even vertical surfaces, smothering flames on walls, and insulating nearby tanks and buildings. Aer-O-Foam can be readily hosed away while wet, or brushed off walls and machinery when dry . . . plants go back into production sooner.
Performance-proved in the oil industry and by the Armed Forces, Aer-O-Foam liquid and equipment is designed by National Foam Engineers to give the utmost in positive, fire-safe protection against all types of flammable liquid fires.
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Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

The Questions and Answers presented here are from a wire recording of the popular "Information Please Session" of the 28th Annual Convention of the Natural Gasoline Assn. of America, in Fort Worth, April 20-22. Their publication is made possible through the co-operation of the various authorities participating, W. F. Lowe, NGAA Secretary, and J. E. Pew, Sun Oil Co., session moderator.

How do you protect the correlative rights of operators and royalty owners in a gas distillate field which requires unitization for a cycling plant or pressure maintenance project?

To answer this question it is first necessary to know under what state laws the unitized operations will be conducted. In Louisiana, where laws and rules have been set up for forced pooling after due process following the necessary hearings, then a program can be developed accordingly. In other states, where there are no laws authorizing forced pooling regulations, it then becomes necessary to have voluntary unitization agreements between the land owners as well as the operators within the limits of the defined field.

In Louisiana, within the past two years my company has completed a unitization program which we believe sets a good pattern for an answer to this question. I refer to our Benton Unit, located in Bossier Parish, near Shreveport.

Two Producing Zones

This field had an area of approximately 10,000 acres. There are two producing zones in the Cotton Valley Series; one is known as the "D" sand and the other as the Bodcaw sand, production from which is approximately 80 ft. under the "D" sand. The "D" sand was a 100% gas distillate zone, whereas the Bodcaw was a combination gas distillate and black oil production zone.

The operators agreed at an early date to the principle of unitization and appointed one company as the operator of the total field area. This was done when there were only five wells completed in the field, of which only three were productive. The lessees agreed they would share development and drilling costs on a surface acreage basis until such time as the field was completely defined and geological as well as subsurface engineering data could be obtained for determination of the economic recovery of the gas and distillate in place under each lease. It also was agreed among the operators and lessees that they would be bound by the determination of these "products in place" as made by an independent engineering firm. Each operator, during the period of development, was free to supply information and data to the firm, and such information was used by it to determine the "products in place" under each tract of land within the unitized area.

By following this procedure, the many bargaining negotiations between lease owners in the unitized pool were eliminated, since the engineering firm selected made an unbiased determination of the actual "products in place" under each lease and tract of land. It also provided a means to go ahead and rapidly develop this field in an orderly manner. It furthermore prevented excessive drilling, such as would be required by conventional "offsetting" development, thereby reducing the overall costs to the individual lessees in the field. At Benton now there are but 17 producing wells in the entire 10,000 acre area; 13 wells in the "D" sand and four in the Bodcaw sand.

Royalty Owner Agreements

This same procedure was followed in getting individual royalty owners to agree to accept the determinations of the outside engineering firm of the "products in place" under their respective lands. The royalty owners further agreed to stand a certain charge against their one-eighth of the products as a "plant processing charge." With royalty owners agreeing to this charge, the operators likewise agreed to pay the royalty owners their one-eighth on the basis of the plant production and not on some percentage figure based on arbitrary field tests, such as has been used in natural gasoline contracts.

After the preliminary determination had been completed by the engineering firm, all data, including engineering and geological information, were presented before the Louisiana conservation authorities for their review and approval. The preliminary evaluation determination stood until one year later, when evidence was presented for making a final determination of values and equities within the unitized pool.

In other words, between the initial signing of operating agreements between lessees and starting of the complete cycling plant operation, the time required was approximately two years. In this plan we feel we have adequately protected the correlative rights of all parties concerned in this unitized field with a minimum of negotiations between both lessees and royalty owners. There have been no serious disputes, no lawsuits and everybody appears satisfield with the arrangements.—H. W. Manley, vice-president, Barnsdall Oil Co., Tulsa.

What are the advantages and disadvantages of refrigerated propane storage versus storage at normal temperatures?

The advantages of storing at pressure, under refrigeration, or insulation and refrigeration are entirely economic. The last cost analysis I know of was made three or four years ago when a very extensive study was made on the cost of butane and propane storage in all types of vessels. The study considered the large 5000 to 10,000 bbl. tanks, 1500 bbl. horizontal tanks, 30,000 gal. tanks, long lengths of large diameter pipe, designed for 50 or 75 psi., refrigerated and insulated.

The conclusion reached at that time was that, over a 10-year period, the cheapest storage per barrel was in the 30,000 gal. plain shop welded horizontal tank. In this connection, it should be mentioned that storage cost in 30,000 gal. tanks has been the cheapest because there has been such a large demand for that particular size for use in marketing and, as a result, many companies have practically set up assembly lines for making that type of storage tank. Since so many of them are being made, naturally they have been a little cheaper than other types of storage but this may not always be true.—E. P. Shelton, District Sales Manager, Chicago Bridge & Iron Co., Tulsa.

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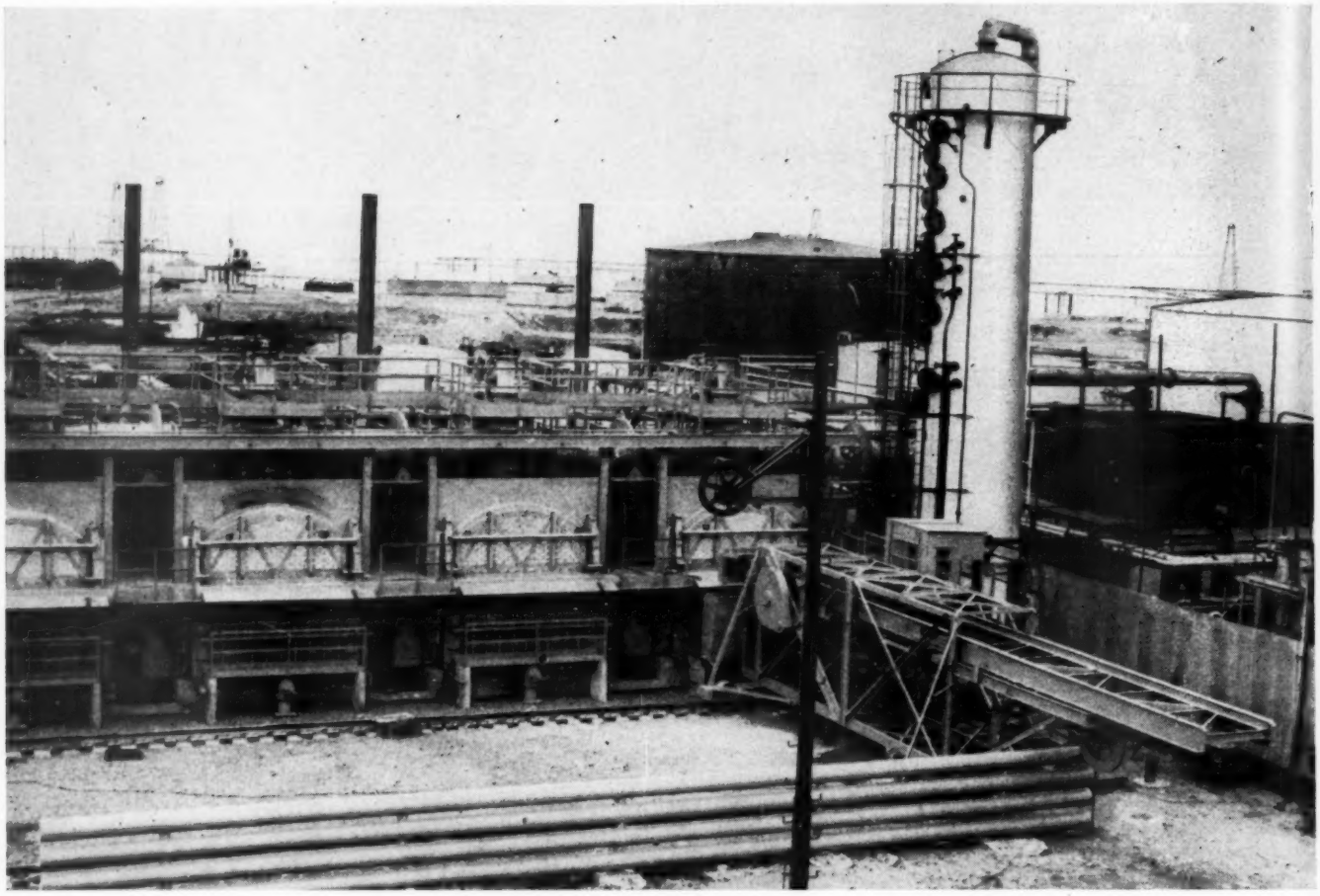

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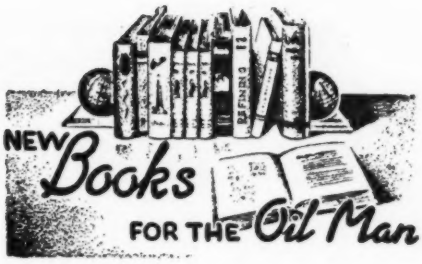


U. S. Edition Issued of Dutch Diesel Cylinder Wear Study

Cylinder Wear in Diesel Engines, by Carl Hoegh; 5½ x 8½ in., 250 pages, stiff cloth binding, $5.00.

The chief merit in publishing American editions of foreign technical books is probably a point which can be argued at great length, both pro and con, particularly when such foreign volumes are relatively old.

Nevertheless, in the case of this first American edition of *Cylinder Wear in Diesel Engines,* its value to lubricant and fuel manufacturers would seem to be in the comprehensive data collected and correlated by the author concerning large marine units. It is pointed out that Diesel operation of this type—extremely large and slow-speed—presents factors of wear considerably different from the smaller, comparatively high-speed installations.

The source of the data is largely operations records of fleets of Diesel-powered vessels, notably those designed, built, and under the management of the author, who is connected with a Dutch shipping company. Unfortunately, cost figures and the like are in terms of British currency, reducing somewhat the value of the information for an American engineer, unless he has ready access to conversion factors.

The age of the original manuscript is obscure and not indicated except by the dates in the literature references listing, in which the most recent is 1940. It would seem the progress during the last ten years in the study of cylinder wear in internal combustion engines, including Diesels, might be of greater value to present-day technologists.

Dr. Wickenden Writes Guide For Engineering Graduates

A Professional Guide for Junior Engineers, by William E. Wickenden; 8½ x 11 in., 56 pages, paper binding, $1.00.

A guide for the professional life of the young engineer, this book presents the philosophy and engineering ethics needed for success as viewed by the late Dr. Wickenden.

It opens with a historical survey of the engineers' heritage, going back to Tubal Cain, and traces the beginnings of engineering societies. From there the author traces the profession through its every aspect—what the young engineer can expect to find, the difference between a trade and a profession, professional relationships, and finally ending with his most famous essay on a philosophy of life, The Second Mile.

Addenda include "Faith of the Engineer," a credo; a recommended reading list for junior engineers; a self-appraisal questionnaire; and the Canons of Ethics for Engineers.

The book is the work of Dr. William E. Wickenden, for 18 years president of Case Institute of Technology. It was begun in 1942 and his untimely death in 1947 came before he completed his final version. G. Ross Henninger, then editor of *Electrical Engineering* and now director of publications for the Illuminating Engineering Society, undertook the task of editing the final version.

It has been published by the Engineers' Council for Professional Development. Copies can be obtained from the ECPD, 29 West 39th St., New York 18, N. Y.

Society Publications

Isotopes and Their Applications in the Field of Industrial Research, by Paul C. Aebersold, the Edgar Marburg Lecture, 1948, presented before the 51st Annual Meeting of the American Society for Testing Materials, Detroit, June, 1948; 6 x 9 in., 28 pages, $1.00 Order direct from ASTM, 1916 Race St., Philadelphia 3, Penna.

Panel Discussion on Influence of Non-Ferrous Metals and Their Compounds on Corrosion of Pressure Vessels, presented at 51st Annual Meeting of American Society for Testing Materials, Detroit, June, 1948; 6 x 9 in., 45 pages, $1.00. Order direct from ASTM, 1916 Race St., Philadelphia 3, Penna.

Report of Progress—Fundamental Research on Occurrence and Recovery of Petroleum, 1946-1947: covering American Petroleum Institute Research Project 37, "Fundamentals of Hydrocarbon Behavior;" Project 27, "Function of Water in the Production of Oil from Reservoirs;" and Project 43, "The Transformation of Organic Material into Petroleum:" 8 x 10½ in., 242 pages, stiff cloth binding. Published through private subscription by the API, 50 West 50th St., New York 20, N. Y., and available on a subscription basis upon application to the Institute.

Mineral Wool Insulation for Low Temperatures, 2nd Ed., Commercial Standard CS105-48 (supersedes CS105-43), U. S. Dept. of Commerce, National Bureau of Standards; 5¾ x 9 in., 26 pages; prepared by joint action of the Bureau and the Industrial Mineral Wool Institute. Copies may be obtained, free of charge, from the Industrial Mineral Wool Institute, 441 Lexington Ave., New York 17, N. Y. Large orders will be filled at the price of 10c per copy.

Unless otherwise indicated, copies of all books reviewed here may be ordered from the Reader's Service Department, Petroleum Processing, 1213 West Third Street, Cleveland 13, Ohio, for the price listed, postpaid. Ohio purchasers please add 3% tax. NOTE: publisher's prices are subject to change without notice.

MEETINGS
. . . for the Oil Man

JUNE

10, Western Petroleum Refiners Assn., Regional Technical-Industrial Relations Meeting, Broadview Hotel, Wichita, Kan.

20-24, American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.

24, Commercial Chemical Development Assn., Open Meeting, Niagara Hotel, Niagara Falls, N. Y.

27-July 1, American Society of Mechanical Engineers, Semi-Annual Meeting, University of California, Extension Building, San Francisco.

27-July 1, American Society for Testing Materials, 52nd Annual Meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

AUGUST

15-17, Society of Automotive Engineers, National West Coast Meeting, Multnomah Hotel, Portland, Ore.

SEPTEMBER

6-8, American Institute of Chemical Engineers, Regional Meeting, Mount Royal Hotel, Montreal (Que.), Canada.

12-16, American Society of Mechanical Engineers, Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

12-16, Instrument Society of America, Annual Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.

14-16, National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.

18-23, American Chemical Society, 116th National Meeting, Atlantic City, N. J.

28-30, American Society of Mechanical Engineers, Fall Meeting, Lawrence Hotel, Erie, Pa.

OCTOBER

2-5, American Society of Mechanical Engineers, Petroleum Division, Petroleum Mechanical Engineering Conference, Biltmore Hotel, Oklahoma City.

3-4, National Assn. of Corrosion Engineers, Smith Central Regional Meeting, Adolphus Hotel, Dallas.

3-5, National Lubricating Grease Institute, Annual Meeting, Roosevelt Hotel, New Orleans, La.

7, California Natural Gasoline Assn., 24th Annual Fall Meeting, Ambassador Hotel, Los Angeles.

10-14, American Society for Testing Materials, First National West Coast Meeting, Fairmont Hotel, San Francisco.

26-27, American Society of Mechanical Engineers, Fuels Division Conference, French Lick Springs Hotel, French Lick, Ind.

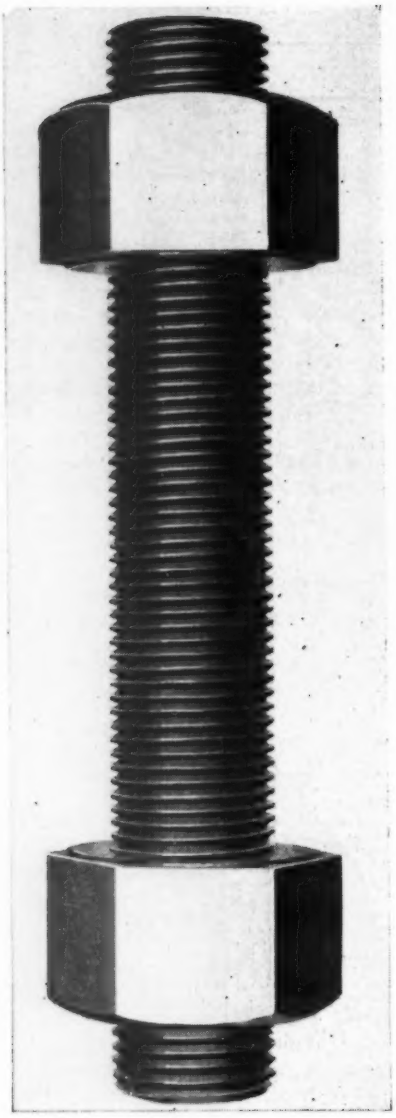
NOVEMBER

1-5, 2nd Pacific Chemical Expo, San Francisco Civic Auditorium, San Francisco

3-4, Society of Automotive Engineers, Fuels & Lubricants Meeting, Chase Hotel, St. Louis, Mo.

7-10, American Petroleum Institute, Annual Meeting, Stevens Hotel, Chicago

27-Dec. 2, American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York



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Personals

Thomas J. Sullivan was elected vice president in charge of manufacturing for Gulf Corp. He began his service with Gulf in 1921 as a foreman of the acid plant at the Port Arthur refinery, and in 1930 became assistant general superintendent at Port Arthur. In 1935 he was made general superintendent of Gulf's Texas refineries. He was brought to Pittsburgh in 1939 as assistant general manager of the manufacturing department and a year later was made general manager of the manufacturing department, which position he held until his recent promotion.

Mr. Sullivan

* * *

D. L. McCann is supervisor of the utility department of the Casper refinery of Socony-Vacuum Oil Co., Inc. He was formerly in the process engineering section of the Socony refinery at Augusta, Kans. He is a graduate of University of Illinois and joined the company in 1937.

* * *

A. E. Makoski is head of the newly organized general service department of the Baltimore Esso Standard Oil Co. refinery, being transferred from the New Jersey works.

* * *

Louis J. Subuski has been promoted to supervisor of the protection department of Esso Standard's Bayway refinery. He has been with the company since 1935.

* * *

William M. Smith is assistant supervising engineer in the process design division of the engineering department, at Esso Standard's Bayway refinery.

* * *

Vice Admiral Earl W. Mills, U.S.N. (Ret.) has been elected executive vice president and a director of Foster Wheeler Corp., New York. **David McCulloch,** formerly executive vice president, has been made vice-chairman of the board. Admiral Mills is a graduate of the Naval Academy, received an M.S. degree in naval engineering at Columbia in 1924, and was awarded an honorary degree of Doctor of Engineering by the University of Louisville in 1944. He was wartime Deputy Chief of the Bureau of Ships, Navy Department, and Chief of that Bureau from 1945 until his recent retirement.

* * *

Gordon Kiddoo is a consultant in New York specializing in the synthesis production of liquid fuels. He has recently been in charge of the Montebello laboratory of The Texas Co. and in the New York office of its technical and research division, and before that was with Hydrocarbon Research, Inc.

* * *

J. Perry Morgan, formerly with Standard Oil Development Co., is now with the New York operations offices of the U. S. Atomic Energy Commission as assistant director of the production division.

* * *

Leonard T. Wilson is assistant refinery superintendent of Shell Oil Co.'s Martinez, Cal., refinery. He formerly was department manager of catalytic cracking at the Dominguez plant. **J. D. Davis,** formerly department manager of gauging at Martinez, will replace Mr. Wilson.

* * *

Max W. Ball is to be awarded a Distinguished Service Medal in recognition of 15 years' service with the Interior Department. From 1946 until his recent resignation he was Director of the Oil & Gas Division and from 1906 to 1917 he was with the Geological Survey and the Bureau of Mines. He has also engaged in various petroleum enterprises and, during the war, was special assistant to the PAW Deputy Petroleum Administrator. Mr. Ball graduated from Colorado School of Mines in 1906 and received his LL.M. from National University, Washington.

Mr. Ball

* * *

Jefferson W. Mitchell, for the past three years advisor on petroleum matters to the Chinese Nationalist government, has been named general manager of the National Cooperative Refinery Assn., McPherson, Kans. He has been in the petroleum industry for 30 years and was manager of Phillips Petroleum Co.'s Kansas City refinery from 1928 to 1940. He studied mechanical en-

gineering at Rice Institute. While in China, his principal duty was rebuilding and managing a 20,000 b/d plant on Formosa.

* * *

Robert H. Ausfahl of Standard Oil Co. of California has received one of the ten Sloan Fellowships to study for a year at Massachusetts Institute of Technology. Ausfahl, a senior analyst in Standard's Department on Organization, was chosen in a nationwide competition.

* * *

Louis B. Wells is manager of Sun Oil Co.'s Marcus Hook refinery, succeeding **Andrew W. MacMurtrie,** who is retiring. He started with Sun at Marcus Hook in 1923, became assistant superintendent in 1933 and superintendent in 1944. Mr. MacMurtrie, retiring after 39 years of service because of ill health, rose from laborer to refinery manager.

Mr. Wells

Mr. Maschal

Mr. Askew

Charles E. Maschal is the new assistant manager at Marcus Hook. He joined Sun in 1933, became assistant superintendent in 1944 and administrative assistant superintendent in 1947. **W. T. Askew** is superintendent at Marcus Hook. He started to work for Sun in 1931 and has been assistant superintendent since 1944.

* * *

Thomas W. Burtt, formerly chief engineer of the El Segundo refinery of Standard Oil Co. of California, has become associated with Ralph M. Parsons Co. of Los Angeles as the general manager of the Los Alamos project, assigned to Parsons by the Atomic Energy Commission.

* * *

W. T. Holliday, board chairman, Standard Oil Co. (Ohio) was the winner in the private individual classification for the 1948 awards made by World Government News. Vice president of the United World Federalists, he was honored for "the great influence which his writing for world government has had upon the minds of millions of people throughout the world."

* * *

Mr. Field

Hugh W. Field, manager of the Research and Development Department of the Atlantic Refining Co., was elected a company vice president at the annual stockholder's meeting. He became a member of the board of directors in 1946. Dr. Field joined Atlantic in 1928 shortly after graduating from the University of Pennsylvania.

* * *

John J. Stanko is manager of the Processing Asphalt Division of the Douglas Oil Co. of California. The Division is to establish a control and computing laboratory at the Douglas Clearwater plant, where facilities will be installed for testing and evaluating all types of asphalt. Dr. Stanko has spent 15 years in the development of asphalt products and was formerly director of research for Flintkote Co.

* * *

Harry M. Mitchell is chief engineer of Jefferson Chemical Co., Inc., replacing **G. R. Wick,** who has been made assistant to the production manager. Mr. Mitchell was formerly assistant chief engineer.

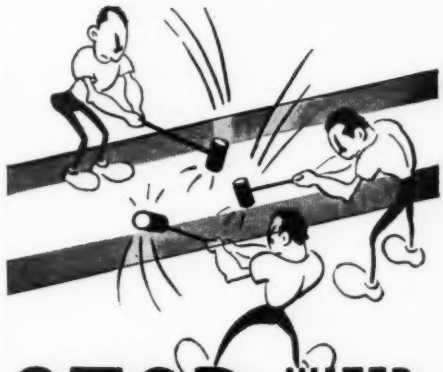
* * *

An oil man since 1894, **Albert E. Daily,** operator in the water treating plant at Sun Oil Co.'s Toledo refinery, was awarded a six-diamond gold emblem in honor of completing 55 years of service with the company. He is the second to complete this length of service with Sun.

* * *

Bonnar H. Barnes has been appointed general manager of Gulf Oil Corp. refineries. He started with Gulf as a chemist in 1921, and in 1929 was promoted to superintendent of the Sweetwater, Texas, refinery. He was later superintendent of the Toledo plant and in 1935 was made assistant general superintendent of the Port Arthur refinery. He was made general superintendent of the three Texas refineries in 1938 and in 1945 he became assistant general manager of the manufacturing de-

Mr. Barnes



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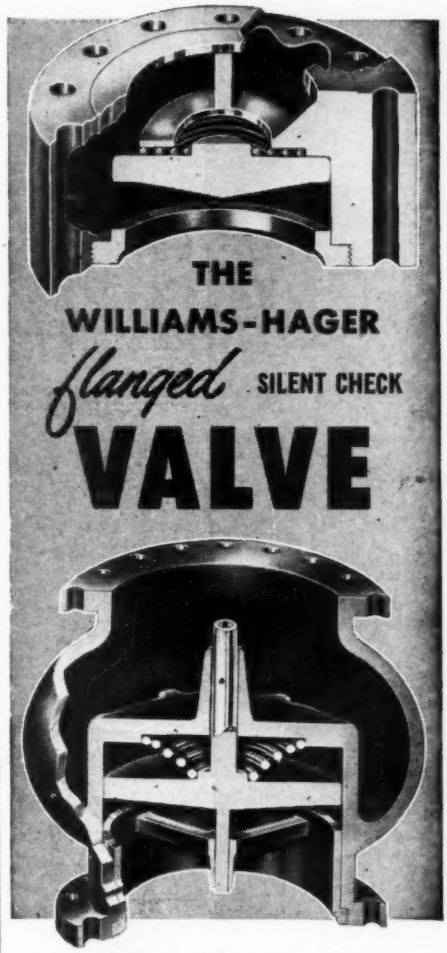

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BOX 31

partment, with headquarters in Pittsburgh. During the war Mr. Barnes was assistant director of refining in charge of refining operators and technical processes for PAW.

* * *

Donald N. McCord is in charge of plant and construction operations of the Glenn H. McCarthy interests. He was superintendent and project manager for Stone & Webster Engineering Corp. for the new $21,000,000 Shamrock Hotel in Houston and had supervised various wartime construction projects.

W. H. Roach is chemist for the gas synthesis plant now building at Brownsville, Texas, for Carthage Hydrocol, Inc. He was formerly assistant chief chemist at the Lockport, Ill., refinery of The Texas Co.

* * *

Mr. Winters

Walter F. Winters is district engineer of the Asphalt Institute, with offices in Denver. He will direct its studies on the potentialities of asphalt in reclamation work and the allied problems of water and erosion control. He was formerly an engineer with the highway department of the Washington state government.

* * *

J. W. Roach has been made division gas superintendent for Stanolind Oil and Gas Co. for the North Texas-New Mexico division, with headquarters at Fort Worth. Plants under his management include the Slaughter gasoline plant near Sundown, Texas and the North Cowden and South Fullerton plants now being built. Mr. Roach was formerly chief project engineer for the manufacturing department in Tulsa. He holds a degree from the University of Texas, and also attended New Mexico A & M College.

* * *

Alan E. Hall is superintendent and **Harold G. Russell** assistant superintendent of the research and development department of the Bahrein Petroleum Co., Ltd., at its Bahrein, Persian Gulf, refinery. Mr. Hall replaces **George S. Windle,** who has been transferred to the New York office of California Texas Oil Co., Ltd.

* * *

M. C. Hoffman is general manager of production and exploration for Root Petroleum Co. A graduate in mechanical engineering of Colorado A. and M. College, he was with the Midwest Refining Co. for 10 years and has since been with Stanolind Oil & Gas Co. at Tulsa.

* * *

Dr. Gustav Egloff, of Universal Oil Products Co., is the new president of the Western Society of Engineers, Chicago. He has been a vice president and trustee for the past five years and, in 1940, was the recipient of its Octave Chanute Medal, awarded annually for distinguished service in some field of engineering. The Society, which is 80 years old, has 2500 members among civil, mechanical, electrical and chemical engineers.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

Industry Must Continue on Guard Against Propaganda for Synthetics

LEGISLATION NOW BEFORE CONGRESS and aimed at putting the Interior Department and its Bureau of Mines in the synthetic oil business will in all probability not be passed this year.

The fervor of the military for the Bureau's program has cooled considerably in recent months—to the point where that group now admits natural petroleum would be able to fuel another war instead of leaving a two million barrels per day deficit.

Supplies of petroleum products are at comfortable levels, exploding the "shortage" scares of which proponents of the legislation made much ado last year.

Additions to our proved reserves in 1948 were practically double production during that period, and present indications are that the same situation will prevail this year.

On top of all that, Congress is faced with a mountain of legislation which will keep it busy until adjournment.

Petroleum technologists, however, should not let the present situation lull them into a state of mind where they no longer see any danger in the Bureau's proposals for establishing a premature synthetic fuel industry.

The danger is still very much present. It will persist as long as the Bureau's synthetic fuels staff continues to stump the country, extolling the progress it is making, predicting frightening future oil shortages, and painting a rosy picture for synthetics with half-truths and innuendoes.

Step in the Right Direction

THE NATURAL GASOLINE ASSOCIATION of America has taken a constructive step in attempting to have the vapor pressure limit for winter-grade gasoline increased to 15 from the present 13.5 psia. Based on its Nowata Road Tests of February and March, 1947, the evidence clearly shows no vapor lock occurred in late model cars with 15 lb. RVP gasoline at atmospheric temperatures not exceeding 55° F. The matter comes up for letter ballot in ASTM Committee D-2 on Petroleum Products and Lubricants before its meeting this month.

The fact that cars can tolerate more light ends without inconvenience to the motorist has an important bearing on the petroleum conservation problem. More of these fractions are now being produced than ever before. State conservation authorities are cracking down on flaring of the light hydrocarbons. Oil fields have been shut down because the accompanying gas could not be used. The Texas Railroad Commission has threatened to force refiners to utilize light ends by a corresponding reduction in crude oil production.

It is doubtful if any important segment of the oil industry opposes raising the vapor pressure limit in the ASTM specifications. One oil company reportedly marketed a gasoline in the northern part of the U. S. last winter with a vapor pressure up to 17 or 18 lbs. Motorists could not detect the difference.

However, certain interests in the automotive industry have indicated recently they would vote "No" on the NGAA proposal. Opposition is said to be based on interpretations of service complaints coming from truckers, and not from test data. It is questioned whether these complaints can be accurately diagnosed as coming from vapor lock. Limited data from Sun Oil Co. tests with trucks, using 15 lb. gasoline, and atmospheric temperature analyses and comparative vapor lock analyses between winter and summer gasolines made by Phillips Petroleum have been used to support NGAA's proposal. General Motors now is running proving ground tests with 15 lb. gasoline in heavy trucks.

This proposal to raise the vapor pressure maximum for winter gasoline to 15 pounds should have the wholehearted support of the refining industry. The related subject of providing the means for greater utilization of light hydrocarbons in motor fuel has been under discussion for years. Here is a concrete step in that direction, under circumstances which are hardly likely to distress motorists.

The Music Goes 'Round and Round'

THE "ALKY-GAS" FACTION of the Farm Bloc is at it again, under their old-time sponsor, Senator Guy Gillette of Iowa, chairman of the Senate's Agricultural Subcommittee. This group has been advocating for a long time the compulsory use of alcohol in gasoline to absorb surplus grain stocks. Now another series of hearings is being held, with the alky-gas proponents using a new talking point—that of conserving "our dwindling oil supplies." History is repeating itself.

The U. S. Distillers of America, Inc., has come up with the idea of adding 1.25% of alcohol to gasoline, which would boost the cost 0.5c a gal. The government would absorb this cost, however, by reducing its excise tax correspondingly on such blended gasoline to keep the "alky-gas" from costing the motorist any more. The U. S. would save in the end, by avoiding possible losses incurred in the grain support program, it is asserted.

Scientifically conducted tests long ago exposed the alky-gas scheme as more trouble than it could be worth in guarding against moisture absorption, separation of the blend into two immiscible liquids in the presence of moisture, comparative costs, and the like. Promoters have "taken" farmers for plenty in such schemes in the past; blamed the oil industry when the promotion flopped.

These newly-heralded schemes to use alcohol in motor fuel are not to be confused with the idea of injecting alcohol into engines as a detonation supressor. The injection idea, as exemplified by such devices as the Thompson Products Co.'s "Vita-Meter", has been shown to have merit and avoids the difficulties that would be experienced with alcohol blended with gasoline. Perhaps the volume of alcohol consumption to be achieved by such means does not appear large enough to be attractive to the alky-gas exponents.

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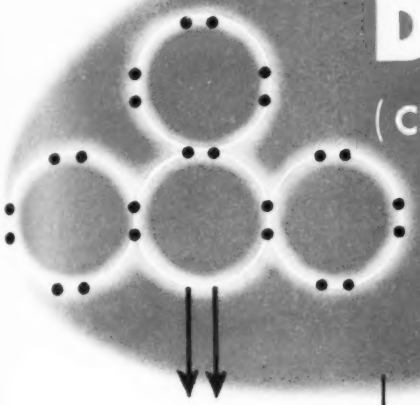

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